THE TECH

SPECIAL ISSUE--JUNIOR WEEK

VOL. XXIX. NO. 141. BOSTON, MASS., THURSDAY, APRIL 14, 1910 PRICE TEN CENTS

TECHNIQUE RUSH COMPLETELY ARRANGED

Editors Give Last Statements On Methods Of Proceedure

History repeats itself. Today at 1.20 the little window in the round house in the rear of the old Art Museum will open and Technique 1911 will make its first public appearance. Certain it is that the appearance of the annual publication will be attended by scenes of the wildest excitement and pandemonium, for one of the greatest honors of an institute career is to be the proud possessor of "Book Number One."

The "rush" is a time-honored event, beginning many years ago in Rogers corridor and growing with such rapid strides that it soon became necessary to transfer the scene of activities to the open plot behind the Art Museum. Here an unrestricted view of the rough-house fs afforded the thousands of interested onlookers.

As usual, the first twenty copies will be numbered on the cover and will contain the autograph of President Richard Cockburn Maclaurin. The scrimmage for the first copy will be unusually fierce this year, since the recipient of this book will be the proud possessor of the first Technique ever signed by President Maclaurin.

As an added incentive for participants, the board of editors of the 1911 book have decided to give away the first five books, these books being de luxe editions. The next fifteen books will be the regular cloth edition, all of them being numbered and containing the president's signature.

The first gun will be fired at 1.15 by Editor-in-Chief Stevens, and will be followed by a second at 1..18. The third gun, giving contestants a fifteen seconds warning, will be fired at 1.19.45. The final gun, at the sound of which the window will be opened, will be fired at exactly 1.20..

The winners of "Book Number One" for the past five years ars as follows: Technique 1906, a tie between Marden W. Hayward, 1906, and Victor H. Paquet, 1905;; Technique 1907,, John H. Leavell, 1907; Technique 1908, Edward R. Smith, 1908; Technique 1909, John H. Ruckman, 1910; Technique 1910, Stewart R. Robertson, 1912.

Robertson last year established for himself the unique record of being the first freshman to win the coveted first copy since the rush has been held at its present place. The next four men to receive numbered copies last year were: A. H. Curtis, 1910; H. S. Gott, 1910; A. Eicher, 1912, and H. C. Davis. Jr., 1911.

SEATING ASSIGNMENTS FOR JUNIOR PROM

Arrangements Are Made For Tuesday Evening For Affair At Somerset

Tuesday at 8.30 the reception for the climax of Junior Week, the Prom. at the Somerset, will begin. At 9.00 sharp the dancing will start. The affair will be over at 3.00 A. M.

The committee will be in the Union, Room A, to sign up the remaining delinquents today from 1 to 2; Friday, Saturday and Monday from 9 to 11; and Tuesday from 9 to 10. It is hoped that the receipts will be obtained early so that the committee can better adjust matters.

There follows a list of the seating assignments. **Those with the higher number in any dance will look up the lower. No Flowers.**

1—C. C. Heild.
2—J. S. Sneddon..
3—H. D. Billings.
7—P. S. Avery.
5—G. S. Watson.
6—John Avery Jr.
7—F.. J. Shepard.
8—C. F.. Goodrich.
9—W. Loyd Allen.
10—Charles Alcot.
11—H. B. Fay.
12—F. H. Daniels.
13—H. K. Franzhcin.
14—Franz Schneider.
15—D. H. Redford..
16—A. R. Atwater.
17—H. L. Kebbon..
18—H. S Arnold
19—G. I. Edgerton.
20—Russel Hastings.
26—C. S. Anderson.
28—C. T. Marcy.
30—Coburn.
32—Dennett.
33—R. B. McEwen.
34—K. Faunce.
35—Sharp.
36—I. W. Wilson.
37—J. O. Greenan.
38—H. C. Davis.
39—Stone.
40—R. M. Barton..
41—H L. Robinson.
42—T. H. Haines..
43—C. B. Cummings..
44—John Herlihy.
45—V. T. H. Bein..
46—E. R. Hall..
47—W. C. Wilson
48—S B. Copland.
49—K. Barr..

(Continued on page 6.)

TECHNIQUE 1911 EXCELLENT BOOK

Editors Have Succeded In Making A Very Original Production

Technique 1911 has more than come up to expectations. A book has been produced that is unquestionably the best yet. It is decidedly unique.

The innovations are so many and frequently so bold that it is a wonder that they were as a general rule so much for the better. But they are, and the Board of Editors deserves and will get great credit for what it has done. It is a book gauged along the broad lines of an expanding Technology. A more detailed treatment follows.

Technique is a summary of the status of Institute life for the year. Therefore judgement must come from the consideration of how well it fulfils this purpose.

THE DEDICATION.

First of all, the editors have shown their ability by honoring not one who has been forced to attention by reason of his position, but rather one who throughout his whole life has not only endeavored to serve the Institute with the best of his powers, but who also succeeded in doing a great deal to establish the name of the Institute as a school of practical scientific principles. He has been the subject of witticisms that have grown up and still remain with us. Instead of repeating the folly of previous books by reproducing these "jokes," this year's book has taken a decidedly wise step by giving well deserved honor to the head of the Physics Department, Prof. Charles R. Cross.

PROFESSORS.

Although also decidely original, the professor pages are perhaps a little broken up for comfortable reading or reference. Originality is very good, but those good points of previous books should not be sacrificed for it. Rather Tecnniques should be a progression of successful ideas.

THE CLASSES.

This department has usually been a question of the proper vehicles for the same ideas. The senior, sophomore and freshman this year really fall into this scheme, although the latter two are decidedly original and well worked up. The junior "play" strikes a new vein. The tendency of so-called "histories" has been to slide over the historical idea and make it more a tool for working out characteristics of members of the class. The scheme of the 1911 "play" is so worked. Althought with absolutely no continued idea of a plot, the charac-

(Continued on page 7.)

MANY EVENTS ON JUNIOR WEEK CALENDAR

Junior Class Technique, And Show Active This Week

Thursday, April 14, 1910.

1.20 P. M.—Annual Technique Rush in lot behind the old Art Museum. First warning gun fired at 1.15, second at 1.18, third at 15 seconds before 1.20. Final gun fired at 1.20 P. M. Copies of the de luxe edition will be distributed at 1.30 P. M. in Engineering B. No books sold tomorrow to men who have not yet signed up.

1.30 P. M.—Special luncheon served at the Union. Free luncheon will be served to the most mauled-up man, the man who has the most outlandish rush togs, and the man who gets the first Technique.

8.00 P. M.—Dance and Reception of the Architectural Society at the Hotel Tuilleries, Commonwealth Avenue. Heads of courses, faculty and students of Course IV invited.

Friday, April 15, 1910.

9.00 A. M.—Press Championship Baseball Game between Technique 1911 and The Tech at Tech Field.

2.00 P. M.—First performance of Tech Show, "The Queen of The Cannibal Isles," at Shubert Theatre.

5.00-7.00 P. M.—Reception by President and Mrs. Maclaurin in the General Library, Rogers Building. Seniors, juniors, alumni, and their friends are invited.

Saturday, April 16, 1910.

2.00 P. M.—Special Tech Show train leaves North Station, Track No. 14, for Northampton. Members of cast and chorus should follow list of instructions.

8.00 P. M.—Second performance of Tech Show at the Academy of Music, Northampton.

Monday, April 18, 1910.

2.00 P. M.—Third performance of Tech Show at the Shubert Theatre.

8.00 P. M.—Annual Concert and Dance of the combined Musical Clubs in Copley Hall.

Tuesday, April 19, 1910.

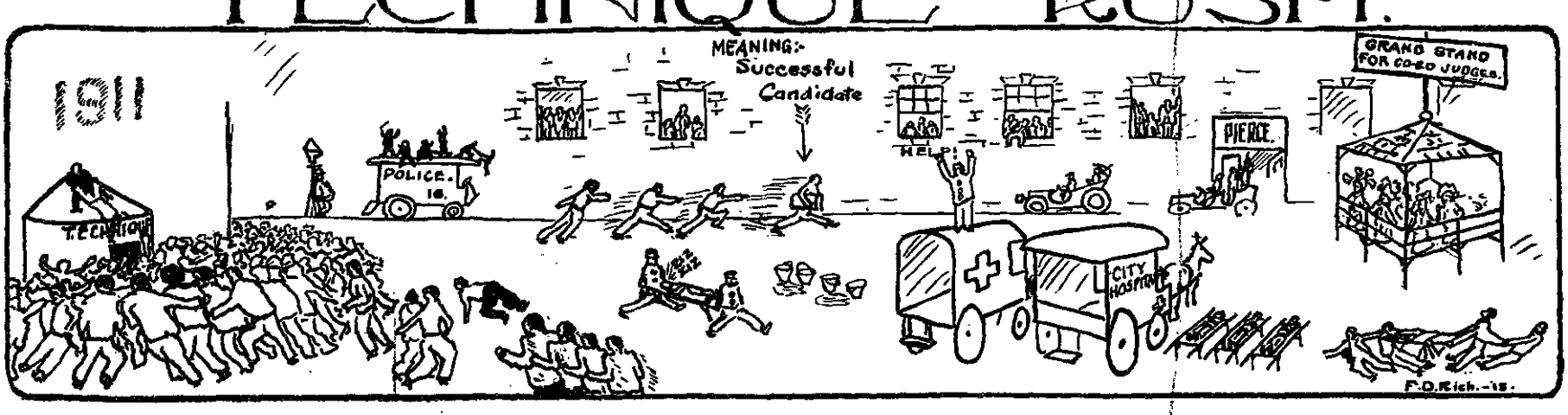
8.30 P. M.—Annual Junior Prom. at the Hotel Somerset, Commonwealth Avenue. Dances will begin promptly and under no circumstances will there be extra dances. No flowers allowed.

Wednesday, April 20, 1910.

5.43 P. M.—Special Tech Show train leaves North Station, Track No. 8, for Malden.

8.00 P. M.—Final performance of Tech Show at Malden Auditorium, Malden.

TECHNIQUE RUSH.



THE TECH

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BOSTON, MASS., AURIL 14, 1910.

Forget those books for once. This is the last opportunity before the last judgement.

This week is the climax of the Social year at the Institute. Whether it is the best ever depends on the individual good feeling between all. Replace egotism and selfishness by general co-operation, and all will be well.

ARCHITECTS' DANCE

Innovation For Their Junior Week Event

In place of the reception which has been given for a number of years, the Architectural Society tthis year will give a dance at the Hotel Tuilleries in honor of the heads of departments. Coming this evening, it will serve as a fitting opening of the Junior Week social festivities. Several novelties will be disclosed, among them being especially designed dance orders and small favors typical of the architectural course. Before the dance a reception will be held. Mrs. .Richard C. Maclaurin, Mrs. Desire Deepradelle and Mrs. Harry W. Gardner will receive, the ushers being Guy Shaffer, Philip Bnrnham, Harold Akerly, John Barnard, Leander Dow and D. W.. Gibbs, all of the class of 1910. Dancing will start at 9 o'clock and continue until 1. There will be 20 dances, and the supper dances will come at 11 o'clock. The orchestrta will be under the direction of Jack Martin, 1912.

TECH UNION SPECIAL

Immediately after the rush Technology Union is to be open to visitors, and it is hoped that many of our friends who have heard us speak so much of the Union, and who have wondered who lives in the Cage, will take advantage of this opportunity to investigate these mysteries. Special guides will (not) be on hand to point out such famous sights as the moodel lunch room, the Cage, the water barrel, the scene of the celebrated dough battle, etc.

A special luncheon will be served in the dining room, which will be resplendent in white table cloths and real cloth napkins. Expert waiters will serve a good menu, while an orchestra of several fragments will discourse sweet music. The doors open at 1.30, and tickets, up to 300, will be on sale on the field oof the Rush and at the door as long as they last. .No young lady should hesitate to ask her escort to take her to the Union for lunch, as the high cost of living hasn't yet raised the Union prices. Now is the time to learn the truth about those classic sayings, "In ((the) Union there is strength," and "Our Union is perfect"; to hear the House Committtee repeat those immortal words of Daniel Webster, "May we never live to see the sun shine down on the broken and dishonored fragments of a once glorious Union," and hear the hat-wearers reply in chorus, "Liberty and Union, Now and forever, one and inseparable!'

Complimentary luncheon tickets will be given to the man getting Book No. 1, to the wearer of the most outlandish costume, and to the "raggedy man" who shows the most damage to his apparel. All will be expected to attend the luncheon in their rush costumes.

Technique 1911 has probably more new ideas, more or less startling, than have ever yet appeared in a single book. Originality is the best of its virtues.

"CIVILIZATION" ENGINEERS.

Mr.. Munroe, after giving a short review of his life at the T. C. A. dinner last night, gave a few reminiscences.

Mr. Munroe said that he had seen something a little while ago that had resembled a dream described by Irving in his "Knickerbocker History of New York" very much. This something was a sight of New York city just at evening, when a bank of clouds had covered up the water front, and above this rose the tall skyscrapers, with their millions of tiny glittering lights, which seemed to blend in with the stars. Then he wondered if large cities, with their tall buildings, were not beautiful in the sense of showing advancement and civilization, iinstead of being huge and ugly, as people nowadays like to paint them. When he again saw New York, Mr. Munroe looked about him and found out that he was right, and this really showed the effect of civilization.

These buildings and monuments and factories are the result of the work of "Civilization Engineers." But along with all these comforts and advantages and luxuries have come many disadvantages, and it is these that we must plan for and must get around.

The men graduated from the Institute are eminently fitted to do this if they will only take care not to be too narrow, but instead will look for the broad side of things and try to do the community good.

GENERAL NEWS

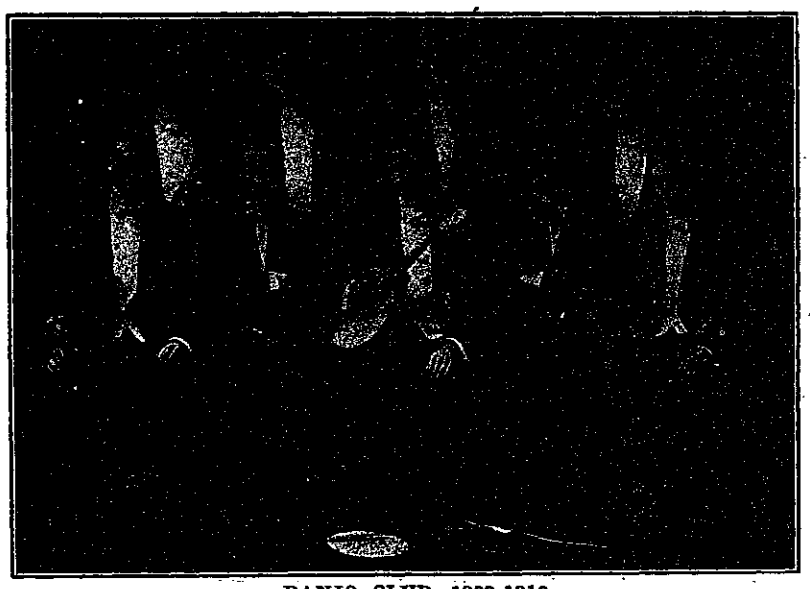
TELEGRAPH NEWS OF THE MORNING.

WEATHER REPORT.

For Boston and vicintiy.—Fair Thursday, light and variable winds.

Boston, April 14.—Joy was unconfined at Tufts College yesterday morning when the hour arrived for the first lectures. A more pleased and self-satisfied appearing crowd of students would be hard to find. Evidently the action of the trustees in deciding yesterday that co-education would be a thing of the past, after the present year, and that in the fall the young women would have a college of their own, gave the young men an opportunity to give way to their glee. Last night they had a great bonfire in celebration. The young women were equally happy.

Boston, April 14.—Ezra Ripley Thayer of this city has been elected Dane professor of law and dean of the Harvard law school, to succeed the late James Barr Ames. The appointment was made some time ago by the Harvard corporation and was confirmed today by the board of overseers at its meeting.



BANJO CLUB, 1909-1910.

SPRING CONCERT COMES MONDAY

Good Programs For Music And Dances Are Arranged

As an event of Junior Week, the annualSpring Concert will again hold its prominent place. The Musical Clubs will appear before an enthusiastic audience in Copley Hall on Monday evening at 8 P. M.

The program consists of eight regular pieces, with probable encores, followed by a dance of eighteen numbers. The selections will be two by each club, a vocal solo by A. O. Wilson 1911, and one combined piece by the Glee and Mandolin Clubs.

The matrons will be: Mrs. Richard C. Maclaurin, Mrs. Henry P. Talbot, Mrs. Allyne L. Merrill, Mrs. Charles B. Breed, Mrs. Edward E. Bugbee.

The members of the reception committee are: W. W. Warner 1911, J. W. Northrop, Jr., 1910, P. L. Caldwell 1911. Harold Sharp 1909, J. S. Martin 1912.

The ushers are: H. D. Williams 1911, J. A. Bigelow 1911, L. C. Cooley 1911, S. B. Copeland 1911, L. B. Duke 1912.

The officers of the combined clube are: R. W. Brush 1910, president; P. L. Caldwell 1911, secretary; W. W. Warner 1911, general manager; J. S. Martin 1912, asst. general manager; GleeClub—P. L. Caldwell 1911, leader; P. M. Hamilton 1913, manager; L. C. Hart 1913, manager; Mandolin Club—J. W. Northrop, Jr., 1910, leader; H. H. Partridge 1912, manager; Banjo Club—Harold Sharp 1909, leader; T. L. Wheeler 1911, manager.

The playing of the clubs should certainly surpass that of previous years, as they have had the benefit of the western trip, when points s far west as Chicago were reached in the mid-year vacation. Besides this is there have been the usual local concerts, among these being those in Lynn and Peabody. Many of the best pieces undoubtedly, as in previous years, have been reserved for encores so that a favorable audience will be well paid for their enthusiastic support.

The musical programme in full is as follows:—

"The Cardinal and Grey," Moody 1907. Glee Club; "Sobre las Olas," Rosas, Mandolin Club; Selection,, Banjo Club Quartet; "My Dream," Tosto, vocal solo by Mr. A. O. Wilson 1911; "Lucia di Lammermoor,' Donizetti, Mandolin Club Quintet; "The Stein Song," Bullard 1887, Glee Club; "The Meteor March," Rice, Mandolin Club: "Dear Old M. I. T.," Wonson 1901, combined Glee and Mandolin Clubs.

The order of dances that will follow:

1 Waltz—First Waltz in Berlin.
2—Two Step—Lily of the Prairie.
3 Waltz—Bright Eyes.
4 Two Step—Rings on My Fingers.
5 Waltz—Oh, What I Know About You.
6 Waltz—Violets.
7 Two Step—Moving Day in Jungle Town.
8 Caprice—Dianthus.
9 Waltz—What's the Use of Moonlight?
10 Waltz—Garden of Love.
11 Two Step—Maid of Cherokee.
12 Waltz—Estudiantina.
13 Two Step—Has Anybody Here Seen Kelly?
14 Waltz—Espania.
15 Two Step—Old Grey Bonnet.
16 Waltz—"Dollar Princess" Waltzes.
17 Two Step—He is the Man Who Owns Broadway.
18 Waltz—Italian Nights Waltzes..

PROVISIONAL RELAY TEAM

Tech Will Be Represented By Fast Squad

In the semi-final trials yesterday for the relay team which will represent the Institute at the Penn relay carnival, the three best times were made by W. C. Salisbury 1911, R. H. Gould 1911, and L. O. Mills 1911. Another trial will be held one week from today. However, as there were thirteen men tried out yesterday, it is unlikely that there will be many changes. It is expected that H. Lockett 1910 will have another trial and his chances for the team are very good.

Owing to a rather strong wind which blew up the straight-away, the times were a little slow. Coach Kanaly promises a team which will be at least the equal of last year's and which should make the Syracuse men travel some to keep up.

Coach Kanaly wishes all track men to know that the Field will be open all through Junior Week, and that he, himself, will be there every morning and afternoon with the exception of Monday afternoon. He urges all the men to take advantage of the vacation nnd get some extra time in on the track in preparation for the spring meets.

TECH VS. TECHNIQUE

Inkslingers To Have Battle On Diamond Tomorrow

Technique is confident of winning the annual baseball game with Tech tomorrow morning, for the journalistic honors of the Institute. Captain Parker says that his men are all in the best of condition and that they expect to give The Tech the privilege of paying for that cask of wholesome "nector" which is to be placed on third.

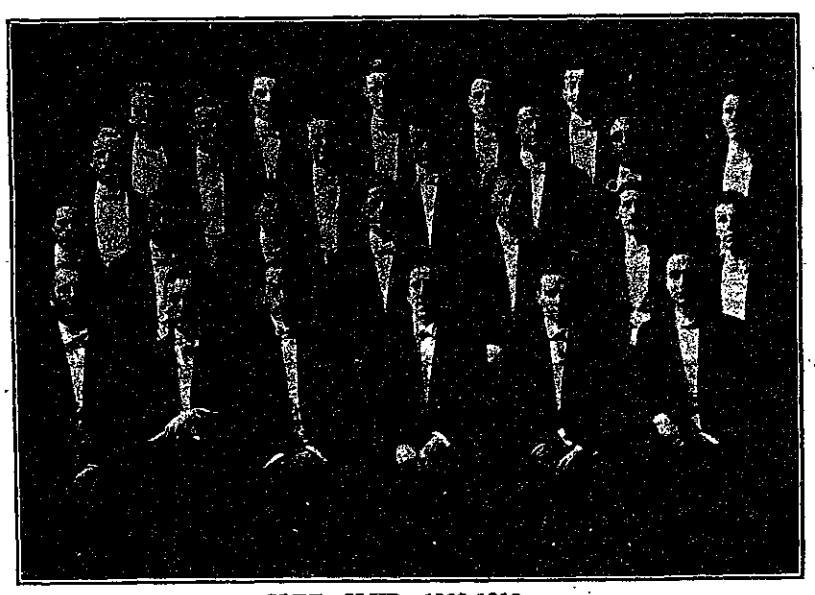
"Don" Stevens, Technique's mighty catcher, will receive the great variety of inshoots, curves and spit-balls of "Tunny" Parker, the well-known warhorse of the 'varsity basket-ball team. Cooley, "Denny" and Duffett make an infield that will keep the poor scribes on The Tech from stealing the bases. In the outfield there will be "Fat" Merrill, Andeson and Bell to catch the few and scattered flies which perhaps will be hit their way. Seligman and Moore from the far West are to be run in as substitutes in case of great need, but Technique does not expect to have to use them. Smith, Hayman, Foster, Bigelow, Faunce, Morey, Salisbury and Wood are to hold themselves in readiness to take the place of any of the injured Technique staff.

The Tech is going to give Ranger, Brooks and Orchard a chance in the box. Fitzy will try to stop them behind the plate, but desires that he be allowed to have two or three men help him out (will the men who get the first five Techniques kindly notice this).

Handy Andy, Tech's lengthy first baseman, Alex Yereance on second, Rankin or Manager-player Frazier on third, are the best that The Tech can get to play in the infield. To show the quality of these players, it can be said that "Don" Frazier, for one, couldn't hold a ball if you put it in his hand.

Jerry Keith, Tyler, Swain, Fallon, Bates, Flansburg, "Rosy," Nealey and McGrath will play in the outfield and substitute.

Conclusion, is the "tonic" on Technique or The Tech? 'Twill be decided at Tech Field at 9 o'clock tomorrow. Umpires Burton and Rand will officiate.



GLEE CLUB, 1909-1910.

HONOR SYSTEM IN EXAMS

Following the custom established in a few other prominent American colleges. the Institute Committee, at their meeting yesterday afternoon recommended to the faculty that an honor system in examinations be established. The "honor system" of conducting examinations is briefly to put each man on his honor throughout the exam. and to have no proctors in the room. The scheme is said to have worked with considerable success at Stevens Institute, University of Virginia, Princeton, Haverford and the University of Texas. The following motions were adopted by the Institute Committee:—

1. We recommend to the faculty that some sort of an honor system for examinations be established at their direction.

2. That a mass meeting be held for the whole student body; that three minutes be allowed each man to speak on the question; and that papers be circulated among all classes and courses for men to indicate their prefrence on the question.

As a committee to arrange for these latter matters, the chair appointed R. S. Breyer 1910 chairman, W. C. West 1911, D. F. Benbow 1912, H. D. Peck 1913, and R. F. Goodwin, ex-officio.

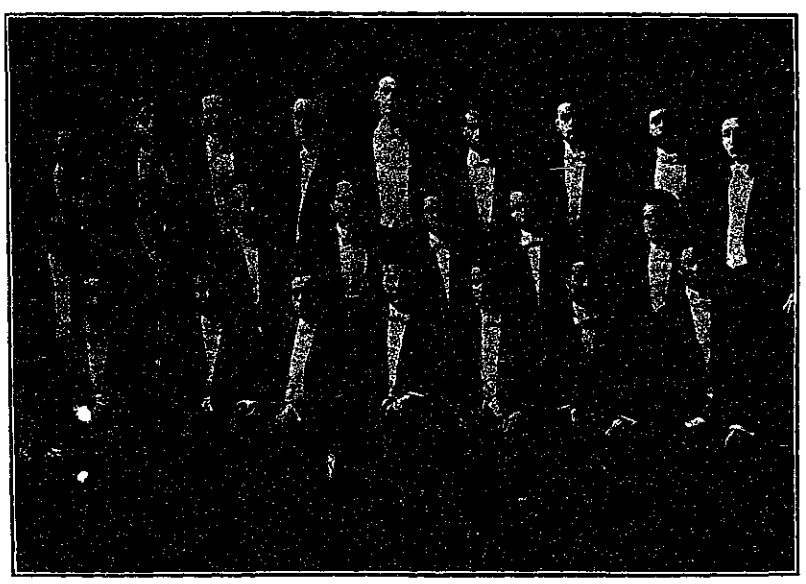
Inasmuch as there has been considerable dissatisfaction with the mail arrangements at the Insttiute, F. A. Dewey 1910 was appointed to investigate troubles and make suggestions to the proper authorities.

Plum Island, April 14.—Mrs. W. Starling Burgess, who will attempt a flight in a Curtiss aeroplane from the new aviation grounds at Plum island today is the first woman to make an ascension in a heavier-than-air machine in Massachusetts.

The first aeroplane for the flights here arrived today from Newburyport on the steam yacht of Mr. Burgess. The machine, which is considered one of the best ever built, is made of spruce. weighing but 400 pounds.

ARCH. SOCIETY DANCE

In place of the reception which has been given for a number of years, the Architectural Society this year will give a dance at the Hotel Tuilleries in honor of the heads of departments. Coming this evening, it will serve as a fitting opening of the Junior Week social festivities. Several novelties will be disclosed, among them being especially designed dance orders and small favors typical of the architectural course. Mrs. Richard C. Maclaurin, Mrs. Desire Despradelle and Mrs. Harry W. Gardner will receive, the ushers being Guy Shaffer, Philip Burnham, Harold Akerly, John Barnard, Leander Dow and D. W. Gibbs, all of the class of 1910. Dancing will start at nine o'clock, and continue until one.

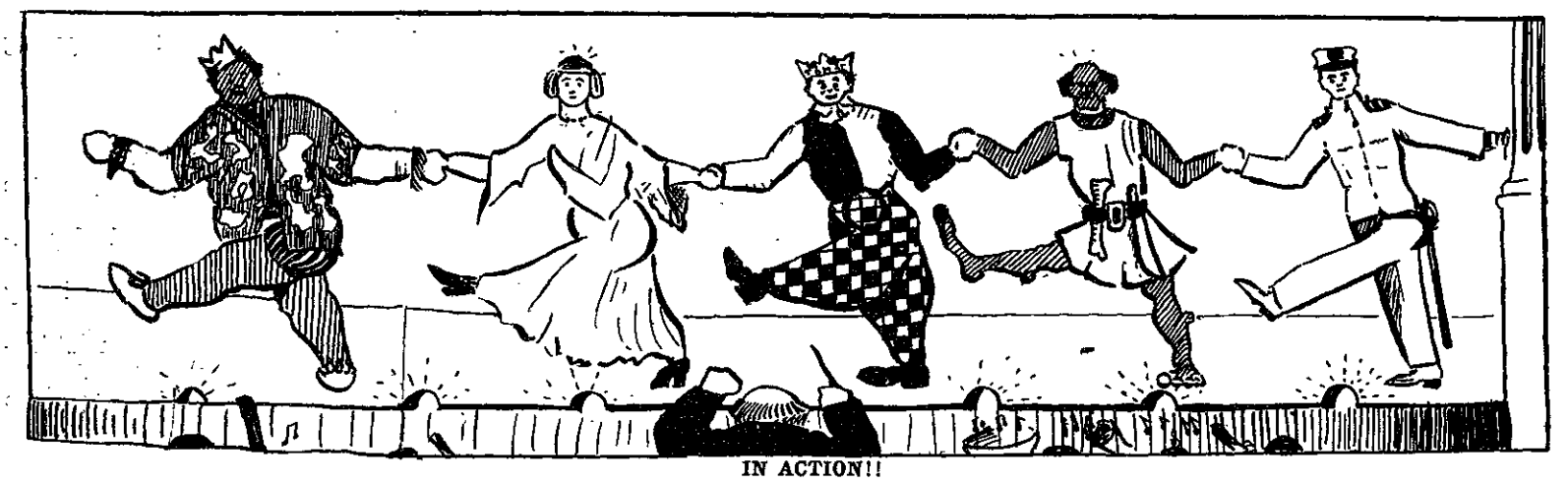


MANDOLIN CLUB, 1909-1910.

THE TECH SHOW PRINCIPALS

CIVILIZED!

UNCIVILIZED!



IN ACTION!!

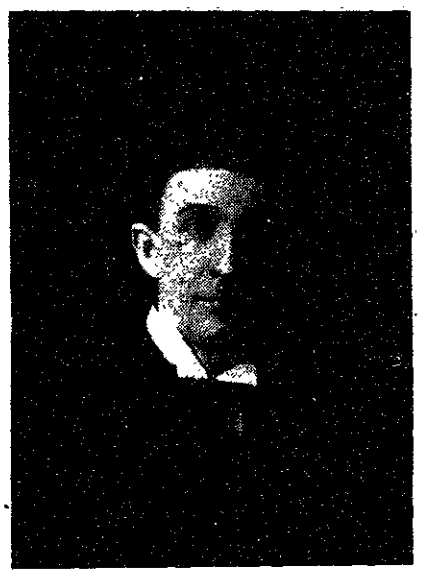
1911 PROM. COMMITTEE.
Top Row—R. H. Gould, P. D. White, G. B. Wilkes.
Bottom Row—S. P. Kimball, S. Copeland, H. D. Williams.

E. C. VOSE, Co-Author of Show.

PROM ASSIGNMENTS

(Continued from page 1)

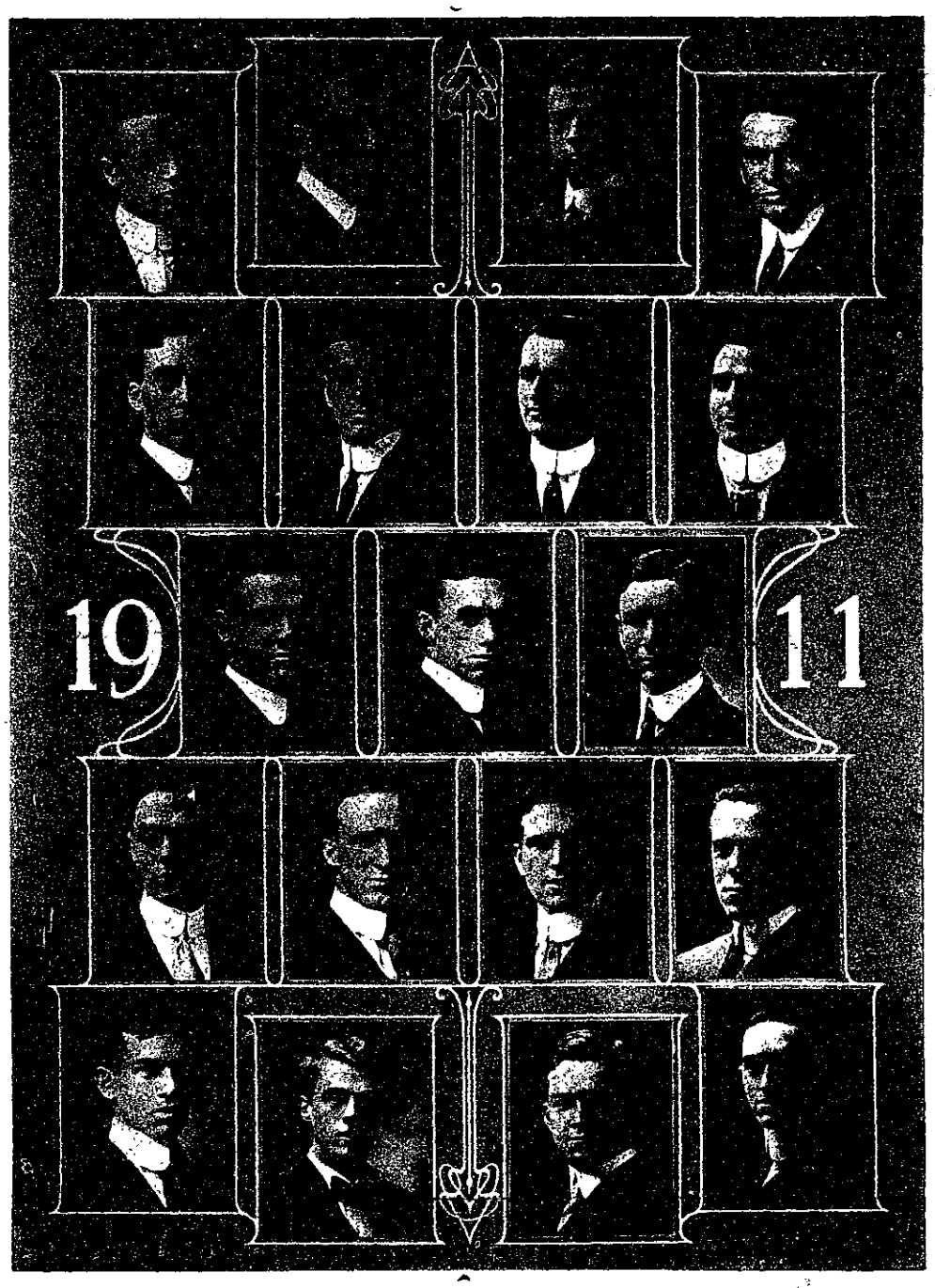
50—C. J. Belden.
51—E. A. Nash.
52—R. D. Wells.
53—H. C. Friebie.
54—K. Greenleaf.
55—E. Montgomery.
56—C. H. Pope.
57—C. F. Hobson.
58—A. H. Barnard..
59—S. P. Capen.
60—P. M. Bramhall.
61—J. B. Pierce..
62—W. Dickens.
63—H. N. Cummings.
64—E. O. Woodbury.
65—C. H. Sutherland..
66—Emerson.
67—E. Wettengill.
68—Foster, W. D.
69—J. Ahlers.
70—O. Hutchins.
71—E. E. Fessenden..
72—C. P. Eldred.
73—J. Karl Mason.
75—G. C. George.
76—Harcourt.
77—M. A. Grossman.
78—H. H. Boyden..
79—H. H. Partridge.
80—J. C. Watson.
81—Ned Wadsworth.
82—Hal Lockett.
83—H. S. Smith.
84—P. K. Wadsworth.
85—J. C. Miller..
86—Whittemore.
87—W. C. Salisbury.
88—Roger Freeman..
89—Fred Barker.
90—S. P. Kimball.
91—Jack Woodruff.
92—R. H. Goodwin..
93—Breyer.
94—Barnwell.
95—Webb.
96—Greene.
97—Roberts.
98—Follet.
99—Follett..
100—Ringer..
101—Hooper.



COACH FRANCIS.

C. A. STEWART, Co-Author of Show.

102—Kerr.
103—Batsner.
104—Parker.
105—Whithe..
106—Wentworth..
107—Fox..
108—Stevens..
109—Mills.
110—Cremer..
111—Moore.
112—H. S. Lord.
114—W. N. Flanders..
116—O. B. Denison.
118—B. C. Cromwell.
119—J. K. Campbell.
120—W. R. Waldo.
122—E. T. Almy.
123—W. W. Warner.
124—Harold Sharp..
125—L. G. Odell.
126—R. H. Rathbun..
127—J. Bigelow..
128—H. D. Williams.
129—E. Stuart.
130—Chaperones Oax.
131—W. O'Hern.
132—B. Reynolds.
133—H. S. Benson.
134—K. D. Fernstron..
135—Rainerts.
137—J. L. Wilds.
138—L. C. Cooley..
139—W. W. Gere..
140—Van Hovenberg.
141—S. Palmer..
142—P. D. White.
143—A. W. Underhill ,Jr.
144—H. S. Merrill..
145—C. D. Wallower..
146—J. L. McAllen.
147—R. E.. Morse.
148—F. S. Smith.
149—N. A. Langie..
150—Lewis.
151—J. Urquhart.
152—James..
153—P. N. Frazier.
154—R. H. Gould.
155—J. B. Nealey..
156—G. B. Wilkes
157—L. S. Fitzherbert.
158—R. H. Allen.
159—R. H. Ranger..
160—Edwards.
161—E. C. Vose.
162—Keith.
163—A. Nagle..
164—Brown.
165—Rowley.
166—Gaillard.
167—D. R. Stevens.
168—Fabens.
169—Tilton.
170—Deiz.
171—Warren..
177—Lowe
1773—A. A. Gould..
174—Selfridge.
175—Dalyrmple..
177—Selfridge..
177—P. Hart.
178—Woodward.
179—W. D. Price.
181—W. W. King..
182—S. E. Reed..
184—F. E. Starr.
185—Cornell.
187—King.
190—A. H. Peycke.



BOARD OF EDITORS, TECHNIQUE 1911.

TECHNIQUE 1911 EXCELLENT

(Continued from page 1)

teristics of a large number of the class are very cleverly portrayed. The stock "history," giving a series of events, brings in absolutely too much of the old staid institutions with their perennial sources of witticism which do not rightfully belong in the only distince class treatise. The class is a decidedly unique thing and it should be here catered to unreservedly. The editors have done well in breaking away from the old "history" idea and treating the junior class as a group of individuals. Bringing all concerning the class together is also a very good arrangement.

ART.

Headings should give a better conception of the title they go with. Technique 1911 has emphasized the humorous vein in its headings. There are many humorous and yet artistic headings, such as are found above the class baseball teams and the M. I. T. A. A. A fine example of the crude and almost pathetic attempts to delineate wit is found where it would be least expected —the two pages of the Architectural Society.

Another idea, decidedly unique, the experimenting of printing the grinds over a light outline of the jester, results in a rather bad combination from the readers' standpoint. The half-tones are ruined by it.

COLOR WORK.

The plates are very well done. The colors register well and are well chosen. The coloring of the headings is poor in places, particularly in the registering..

ATHLETIC.

In Athletics is given the only running account of events. It is very well drawn up and is aided here and there by a few well-chosen comments. The compilation of cuts is very good.

FRATERNITIES.

The Fraternities have been placed further back in the book. This is a decided improvement in arrangement, as the more general departments should be treated first. The title page is a very good idea fairly well epressed.

ORGANIZATIONS.

The Publications, Musical Clubs and other Institute Organizations are each given a little paragraph on its construction. This is step in the right direction. As pointed out at first, Technique should really be a refrence for the present, past and future.. The lists of names are important parts; the explanatory paragraphs add. Would not the value be further increased by short resumes of the work of the current year in each organization?

GRINDS.

Although the border line between what is and what is not a grind has become rather hazy, the grinds are up-to-date, with none of the ancient and honorable included. Some of the poetry herein displayed starts off with the good old rhythm, but ends up somewhat as an April fools' joke.

WORKMANSHIP.

The book as a whole is very well made. The cuts are exceptionally good. The paper is fine. The type is delicate —not too heavy. One thing not quite right is the varying intensity of the ink Any one part by itself is all right, but the rather mottled effect spoils some of the pages.

SPECIAL FEATURES.

Some of the original ideas that were very successful may be mentioned:

The de Luxe Edition, which worked up very well; the neat reproduction of the Show posters; the pictures of this year's Show, although this does break the sequence of the annual by leaving out last year's; the pictures and account of the Reunion; the pictures of the Civil Engineering Summer School.

On the whole, the Board of Editors of Technique 1911 is to be congratulated for what they have produced. It is small, neat and attractive. Without doubt they would do it differently in many places, had they to do it again. Still, they have certainly advanced the production along rational as well as original lines.

R. H. R.

TECH SHOW CHORUS.

FIRST PERFORMANCE OF SHOW TOMORROW

Synopsis Of Tech's Annual Musical Comedy

The first performance of Tech Show 1910, "The Queen of the Cannibal Isles," is to be given at the Shubert Theatre tomorrow afternoon at two-o'clock. A musical comedy in three acts, with fourteen principals and a chorus of fifty, and twenty-two of the best songs ever written for a Tech Show, the production promises to be a great success.

Synopsis:—

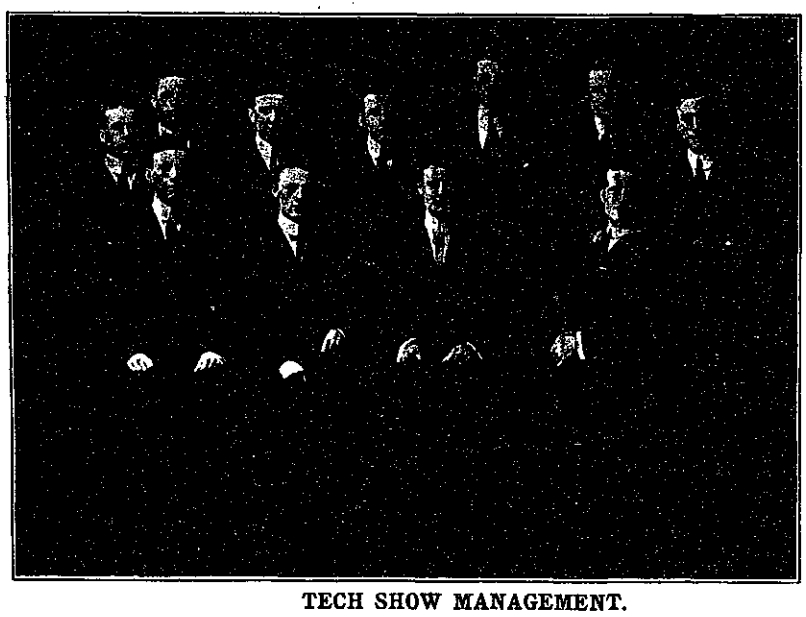
Lest the unwary traveler in his enthusiasm spend fruitless months searching for the mythical Cannibal Isles in the broad bosom of the Pacific Ocean, it may be well to warn him that no one has ever found them with the exception of Bluffem Jones and the band of shipwrecked tourists. And besides, now that Bluffem has married the beautiful Queen Liliokezooka, the kingdom has been scattered to the four winds and is no more.

Handi Singh and Datto Gohr, the Queen's advisor and captain of the royal guard respectively, plan so to change the laws of the kingdom that the Queen will have to marry before she is twenty-three, or in less than three months, the husband selected to be the one paying Handi the largest sum for the privilege. Handi and Datto are then to divide the profits and live happily ever more. But at this juncture a party of tourists, among whom is one Bluffem Jones, a Boston newspaper correspondent, is shipwrecked on the island and brought before the Queen. Bluffen is selected for the stew the next day, but by his cleverness wins the affections of the Queen and incidentally the lives of his fellow travelers. In the meantime the conspirators have arranged with Coco Cola, King of Boozeland, to come over to marry the Queen. So one of the court ladies, Katimaori, is substituted for the real Queen, and is passionately wooed by King Coco.

All is settled, the conspirators discovered, and a double marriage is pending, when a rescue party, led by Lieutenant Jack Gordon, U. S. N., lands to save the tourists from the clutches of the Cannibals. He finds among them his sweetheart, Bobby Schlick, who straightway falls into his arms, and the final curtain falls with everybody happy except Handi Singh and Datto Gohr.

The libretto was written by E. C. Vose 1911 and C. A. Stewart 1912, and is unique in that it was built up around the songs as a framework, with the result that they are much more apropos than is the case in the ordinary musical comedy. Eleven of the songs were written by J. S. Martin 1912, six by O. B. Denison 1911, two by R. H. Allen 1910, and one each by S. B. Putnam 1911 and H. A. Hale, Jr., 1910. The lyrics were written by E. C. Vose 1911, B. V. Reeves 1912, R. H. Allen 1909 and D. Clapp 1910.

Due to the hard work of Coach Francis and the courtesy of the Shubert Theatre, it has been possible this year for the management to obtain the most elaborate scenery that a Tech Show has ever before had. It is that used by the "Green Bird."

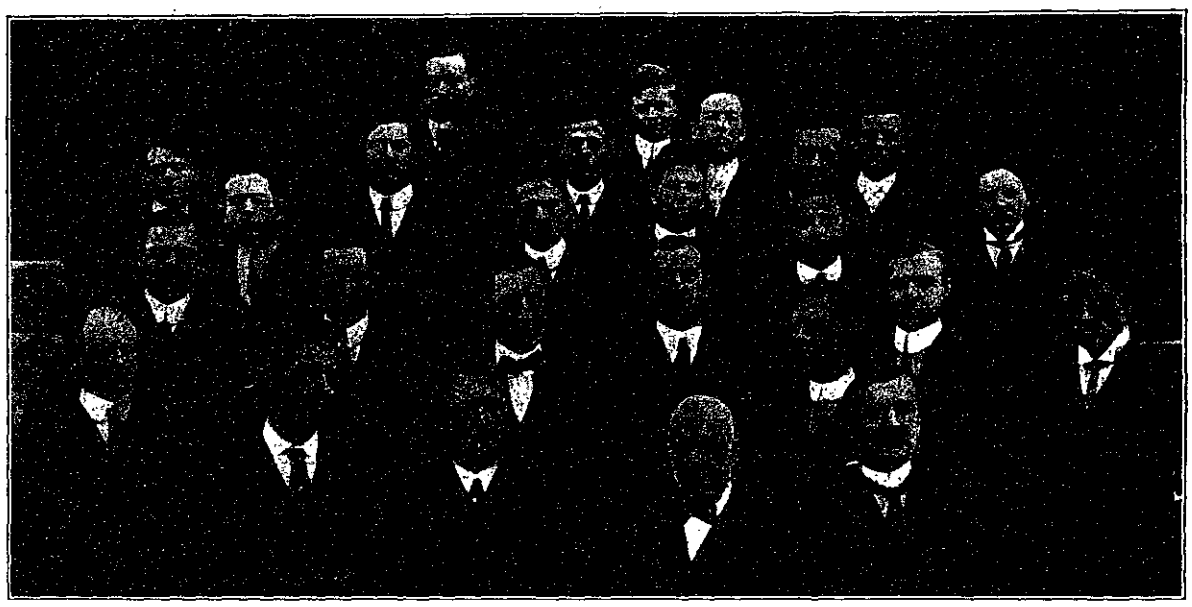


TECH SHOW MANAGEMENT.

THE TECH

SPECIAL ISSUE--PHYSICS AND ELECTROCHEMISTRY

VOL. XXIX. NO. 141. BOSTON, MASS., THURSDAY, APRIL 14, 1910. PAGE 65.



Instructors and Students in Courses VIII and XIV

ELECTROCHEMISTRY

By H. M. GOODWIN.

Course XIV—Electrochemistry—is of so recent development at the Institute that its history is necessarily brief as compared with that of most of the other Institute Courses. A consideration of the evolution of the course into its present form and of the conditions in the industrial world, which have led up to its establishment and given rise to the profession of electrochemistry, is not without general interest however, and should be of value to those who are contemplating electing electrochemistry as a profession. It will indicate the character and scope of the problems which an electrochemist is likely to be called upon to solve and will help to answer the question so frequently asked by prospective students, "What is Electrochemistry, and for what does it prepare a graduate on leaving the Institute?"

As a recognized profession, electrochemistry is the most recent of those which have arisen through the application of electricity to industrial problems of the day. Its evolution has taken place in much the same way as that of electrical engineering, which in the early eighties was hardly more than that branch of applied physics dealing with the application of electricity to such infant industries as telephony, electric lighting, and later electric railroads, etc. The first Course in Electrical Engineering in this country was offered at the Institute in 1882 as a distinct branch of the Course in Physics,—"Physics B." From small beginnings it has developed, until at the present time it is second to none in importance and magnitude. As soon as it became apparent that a demand for men trained in the combined sciences of electricity and chemistry was becoming felt in the community, the Department of Physics likewise inaugurated the Course in Electrochemistry, at first as an option of Course VIII,—"Option 3,"—this being a natural development of the instruction in electrochemistry which had been given regularly by the writer to students in physics and in other courses since 1894. The curriculum of studies forming this option was first announced in the spring of 1901, the course being at that time, it is believed, the only one of its kind offered in the United States.

During the summer of 1901 the writer, accompanied by Professor Thompson, made a tour of the electro-

(Continued an page 68.)

HISTORICAL SKETCH OF THE COURSE IN PHYSICS

By CHARLES R. CROSS.

From the first conception of the plan of the School of Industrial Science of the Institute in the mind of its founder, Professor Rogers, the importance of the study of physics, both pure and applied, was clearly recognized. In that remarkable document, "The Objects and Plan of an Institute of Technology," issued in 1860, it is said under the heading "School of Physics," that "another leading department of the School of Industrial Science would be that of General and Applied Physics," and this is followed by a detailed statement of the nature of the study thus contemplated. And from the opening of the institution to students down to the present day the subject of physics, together with mathematics and chemistry, has been assumed by the faculty to constitute the basis upon which the professional instruction must necessarily rest,

In the "Scope and Plan of the School of Industrial Science," 1864, Professor Rogers further sets forth the desirability of laboratory instruction in physics beyond the customary lecture courses, whereby the student may be taught the processes employed in various physical measurements.

This conception of a physical laboratory, designed for the regular systematic teaching of students in classes, was an *entirely* new one in every respect. Advanced students had carried on physical researches in the foreign universities, and in a few instances, as in Sir William Thompson's laboratory in the University of Glasgow, undergraduate students apparently had sometimes been allowed to work as volunteers, to aid the professor in some of the researches upon which he was engaged at the time, but, so far as it appears, nothing beyond this had been suggested. In this country there was no instruction given in the subject beyond the ordinary collegiate courses of lectures.

It was not until several years after the opening of the Institute that the original intention of Professor Rogers could be carried out. It was a matter of great difficulty to organize such a laboratory. There was no experience elsewhere which could serve as a guide; the methods which had sufficed in the chemical laboratory were not applicable, a series of experiments had to be devised which were within the grasp of undergraduate students, which should be capable of completion within one or two hours, together with apparatus of a simple character, not too complex for ready manipulation by the unskilled student. There was no text-book available, so that one had to be written for the purpose, and manuscript notes had to be used meanwhile, as there were then none of the present neostyling processes in existence and the typewriter was a thing of the future. Furthermore, there was the very serious difficulty of expense, since it was quite beyond the power of the Institute to purchase any considerable number of instruments of precision. These obstacles were all surmounted, however, by the knowledge, skill, enthusiasm and indefatigable perseverance of Professor Edward C. Pickering, then Thayer Professor of Physics at the Institute, and the Corporation having assigned the needful room, in October, 1869, the Physical Laboratory of the Institute was opened to students, and systematic laboratory instruction to classes in physics was then given for the first time in the world. A little later the Corporation voted to give the laboratory the very appropriate title, "Rogers Laboratory of Physics."

The rooms originally assigned to the laboratory were those in the Rogers Building, now numbered 12, 13, 14, and the west half of the present General Library, the remainder of which was subsequently added. The physical lecture room was next to the President's office, where rooms 10 and 11 are now.

Several students in the Institute, of whom the writer was one, even prior to the opening of the laboratory, had desired to make a specialty of the study of physics to a greater or less extent, and to such persons more detailed instruction had been given, including considerable experimental work. Also, a little later, a number of advanced students entered the newly-established laboratory to pursue special investigations, which resulted in the publication of several valuable scientific papers. During the summer of 1872 the laboratory was opened for the benefit of a number of college professors who were desirous of studying there. These facts made it apparent that there had come to be a distinct need of a systemati-

(Continued on page 68.)

PHYSICS AND ENGINEERING

By LOUIS DERR.

If we follow the dictionary and define engineering as the art of constructing civil or military works which require a special knowledge of machinery and the principles of mechanics, we may at once declare that the relation of physics to engineering is that of the foundation to the house; for the laws of motion and the action of forces are among the fundamental propositions of physics. Widely differing applications of physical laws are made in the various branches of applied science, but the fundamental principles are the same in all. In fact, the extension of engineering into fields previously unknown makes a good knowledge of physics indispensable to the engineer, many of the most important problems of engineering being really questions of physics rather than of engineering as such.

This is especially true in engineering research. The extension of our knowledge of the properties of steam, both saturated and superheated, affords problems of great difficulty, but of physics rather than mechanical engineering; the increasing use of high and low temperatures in the arts necessitates the development of methods for their measurement and control, and these too are primarily physical rather than mechanical problems. The endeavor to produce better illumination for our streets and houses at a smaller energy cost has brought forth a host of new illuminants, the investigation and improvement of which are studies for the physicist rather than the electrical engineer. The fixation of atmospheric nitrogen, perhaps destined to have a profound effect upon agriculture, seems to be a problem in physics having very little to do with chemistry; the development of telephony and telegraphy, "wireless" and otherwise, is the story of the discovery and adaptation of one physical fact and law after another; and the list might be extended indefinitely. Physics does not concern itself with the great tasks of organization and finance; but no engineering project can be permanently successful that is not built solidly upon the natural laws that have been discovered and unified by patient investigators whose very names are in many instances forgotton.

It is not necessary to limit the argument to the advanced problems of research. A knowledge of some of the simpler propositions of physics will oftentimes save considerable wasted effort in every-day work. A few instances may be of interest in this connection,

(Continued on page 67.)

COLLEGE TEACHING

By G. V. WENDELL.

The special course issues of The Tech which have been appearing during the college year have been of interest to me and, I am sure, to other alumni readers as offering a concise statement of the history and growth of the Intitute courses since our student days. To the Freshmen, these frank talks by the professors and graduates must have served to give a closer, perception of the meaning of the various branches of engineering and thus have materially aided them in a wise choice of a course of study. To the other undergraduates they must have given a clearer appreciation of the splendid opportunities for service in the field of engineering and in industrial life. The realization of the need of the conservation of our great national resources and the engineering and scientific problems involved must have served to quicken their investigation, enlarge their aspirations and deepen their conviction of the need of availing themselves of the unexcelled training for such service offered by the Institute.

The course in Physics, known as Course VIII, prepares a student to become a teacher of physics or to undertake investigations in that science. With this aim in view those in charge have endeavored to give with a comprehensive treatment of physics an adequate training in chemistry and mathematics. At the same time the humanistic subjects have been given the large place they deserve in the proper development of the teacher. The actual selection of subjects and the allotment of time to each must commend themselves to any thoughful person. The presence in the course of applied electricity is of value to the student who intends to teach phisics in an engineering school, both for the subject matter and also as an indication of ahe fundamental importance of physics in engineering. The wise selection of required subjects, combined with an unusually complete lecture and laboratory equipment, the insistence on work being intellegently and thoroughly done, the opportunity for association with earnest students of engineering and with those engaged in research make the Institute's Course VIII the equal of any undergraduate course in the country leading to a B. S. in physics. Another admirable feature is the close personal relation between the instructors and students of the department.

The presence at the Institute of older students engaged in research and in graduate study for the doctor's degree must have its beneficent reflex action on the undergraduate student in physics. The latter must learn through association with these men the importance of research and the necessity of further study after graduation. I cannot urge too strongly upon the undergraduate in physics who plans for a College teaching career, the prime importance today of graduate study. Excellent and thorough as the instruction in Course VIII is, the training of the men already in the profession and the remarkable increase in the number of graduate students in physics in the universities of this country and of Europe make the competition so keen that only men of the best attainments can expect to hold the places of leadership.

Not merely should every undergraduate who expects to enter college work plan to take a Ph. D., but he should arrange his graduate studies with great care. The mere asquisition of a doctor's title for its influence in securing a position should be put aside as unworthy of a true scientist.

My advice is to devote on the completion of the Institute Course two, three or four years to the acquirement of a training that will qualify the student for a greatest efficiency. Such a program of study entails naturally a considerable financial outlay which may seem to many students an unsurmountable obstacle. The difficulty is more apparant than real, however, for it shold be remembered that many universities as well as the Institute offer graduate scholarship, followships and even assistantships that place the possibility of graduate study within the reach of nearly all worthy students.

The profession of Physics offers an interesting and useful career both as a teacher and as an investigator. It should be borne in mind, however, that to enjoy the fullest fruitage a thorough preparation is indespensable.

HEAT MEASUREMENTS

By C. L. NORTON.

The Laboratory of Heat Measurements is unique among the technical laboratories of this country. Systematic work in this line may be said to have begun at the Institute when the rapid development of electric measurements called to Professor Cross' attention the similar development which was to be expected in the industrial world along the line of heat engineering. It was in 1884 that this work was begun, under Professor Cross' inspiration and with the co-operation of the late Professor S. W. Holman.

In 1897, with enlarged quarters and considerable increase in apparatus, the writer was given charge of this work. While distinctly a physical laboratory course, the instruction in heat measurements is given to the engineering students, as well as to the physicists, and might properly be counted as a professional subject in most of the engineering courses.

In the early days of this work a pyrometer was viewed by an average engineer or manufacturer as a most fickle and untrustworthy instrument, and to attempt to determine the heat of combustion of fuel with an idea to economy in the operation of power plants was to experiment with a fanciful and vain thing. The progress of the industrial world along these lines has been so great, however, that nowadays all the important industrial operations are watched very carefully from a thermal standpoint. The number of processes whose economical operation depends upon the proper adjustment of temperatures, or the regulation of the amounts of heat involved, is quite comparable with the operations whose success depends upon purely mechanical control.

Special instruments for the measurement of all sorts of thermal quantities have become available. The fear of the exhaustion of our natural fuel resources has greatly stimulated the interest in the economy of all processes of combustion, and it is scarcely an exaggeration to state that the manufacturer who does not concern himself with the heat of combustion of his coal is almost as remiss as he who does not concern himself about the accuracy of the weight. The growth of all the methods of insulating hot and cold receptacles, refrigried on in the laboratory is the calori warehouses and kilns, has led to great studies and developments in the matter of insulation, and to this and the fuel problem has been devoted a great deal of the time of the instructing staff of the Laboratory of Heat Measurements for the past fifteen years.

One of the most interesting developments of the work which has been carbut of marker efficiency as workmetric apparatus for the determination of the efficiencies of fuels. This has been developed commercially by Mr. C. J. Emerson, formerly an instructor in the laboratory, and has been adopted as a standard instrument for this purpose. The original bomb of this type was made by the writer for Professor Holman in 1895.

To the students in mining and metallurgy, the position occupied by heat measurements is somewhat similar to that occupied by chemistry, and in many metallurgical operations the questions of heat and temperature are quite as vital in determining the metallurgical results as are the questions of chemistry.

The great fire loss of this country has at last brought us to a systematic and thorough study of the problems of fire prevention, and it has been the privilege of the instructing staff of the Laboratory of Heat Measurements at the Institute to serve in a sense as pioneers in this campaign of fire prevention.

Instruction to the undergraduate students is given in the measurements of such heat quantities as enter into all the teachnical and engineering problems suggested above. The equipment of the laboratory is very complete, and might be said to be essentially a working equipment, containing little material of historic interest or of museum value, but of the marked efficiency as working instruments of instruction for undergraduate students.

The short course of lectures, which precedes the laboratory work, is taken by the students in Courses III, V and VIII. The laboratory experiments themselves are varied for students in the different courses, to make the instruction bear more directly upon the professional work. Since the determination of high temperatures is of much importance to students in Course III, special stress is laid upon this work. The chemist, on the other hand, is oftentimes more concerned with the possibility of maintaining and measuring a lower temperature with a very high degree of precision, and the special apparatus which is available for measurements of this kind is used by the students in Course V in the laboratory. Again, the mechanical engineer is oftentimes more concerned with the determination of the heat of combustion of fuel or the insulating efficiency of steam-pipe coverings, and the students in Course II perform laboratory experiments for the determination of these quantities. These illustrations will perhaps show the scope of the laboratory work in the different courses.

Professor Cross' prophecy of 1884, that the Laboratory of Heat Measurements would ultimately be comparable in scope and size with the Laboratory of Electrical Measurements, seems in a fair way to be realized.

GOVERNMENT WORK

By DR. G. K. BURGESS.

Graduates of Course VIII. find their way most readily into positions requiring proficiency in the mathematical and physical sciences, and of such positions there are many in the Government Service and their number is on the increase. An enumeration of the various scientific and technical branches of the Government Service to which graduates of this course are eligible for appointment to positions immediately after graduation from the Institute, compared with the small number, six, of Course VIII., men actually so employed, leads to the belief that the Course in Physics could with advantage attract more men than has been the case heretofore.

Let us pass briefly in review those departments of the United States Government for which Course VIII men are especially well prepared to enter.

In the Department of Commerce and Labor are the Coast and Geodetic Survey and the Bureau of Standards. In the latter there are at present fifty-eight positions, held by persons trained primarily as physicists, with salaries ranging from $900 to $5,000, at an average of $1,550, and grouped as Laboratory Assistants 24, Assistant Physicists 24, Associate Physicists 8, and Physicists 2. This range of salaries is fairly typical of the scientific positions in the Civil Service.

Although the Coast Survey has no positions designated by name as Physicist, yet in fact there are a considerable number connected with its various division, such as magnetic, tidal, geodetic, and computing, which a man trained as a Physicist is well prepared to fill.

The greatest variety of positions, however, for which Physicists are required, is to be found, perhaps, in the various bureaus of the Department of Agriculture. It is beginning to be appreciated, for example, that scientific meteorology is a branch of physics, and in consequence the Weather Bureau now possesses its Mount Weather Observatory, which is essentially a physical laboratory, and a small corps of Physicists. The bureau of Soils, of Plant Industry, and of Forestry, likewise have their Physicists, as in fact do most of the scientific and technical bureaus.

Among the Bureaus of the Interior Department where Physicists may be found are the Patent Office and the Geological Survey, especially in the Technological Branch of the latter.

There are several technical bureaus in the Departments of War, the Navy, and the Treasury, in which there are positions for which Physicists in fact if not in name. Among these are the Bureaus of Ordnance, Steam Engineering, Equipment (including the Wireless Service of the Navy), the Hydrographic Office, Signal service (Wireless for the Army), the Supervising Architect's Office, and the Customs Service. The Naval Observatory is also an institution to which a Course VIII. man may legitimately aspire; and if he wants to be a teacher in the Government Service, there are the professorships in mathematics at the Military and Naval Academies.

Finally, the Smithsonian Institution, with its small but distinguished scientific staff of the Astro-physical Laboratory, which alone of all the scientific institutions in the country has the unique distinction of being composed exclusively of graduates of Course VIII.

Appointment to positions in the civil service is made only after examination by the Civil Service Commission. For scientific positions, there is usually a written examination together with a rating based on the applicant's training and experience. The written examination is rarely waived except for the highest positions. There is no politics in the civil service, and the tenure of office is usually as secure as a man cares to make it, since the men in scientific positions who leave the service, almost invariably do so to better themselves.

For positions in which ability to carry on independent research is required, it is almost a necessity for the candidates to have a doctor's degree, or at least to have shown an equivalent proficiency by his publications.

The scientific atmosphere of Washington is stimulating and there are a dozen Course X., I changed to Course VIII., with a local membership of over two thousand, so that no one lacks for a sympathetic audience before whom to expound his pet hobbies.

ASTRONOMY

By C. G. ABBOT.

I regard the Physics course at Tech as an ideal school for the astronomer, although in my time actual astronomy received little attention in Course VIII. My own experience with it may have been more limited than that of others, for after completing my second year in Course X., I changed to Course VIII., and graduated with my class, so that all the astronomical study I took at Tech comprised the reading of Young's General Astronomy during a summer vacation. It may indicate a mild form of treason to chemistry on the part of our honored Dr. Noyes, if I add that my change of course was made because he told me that, in his view, one who was interested in molecules ought not to be a chemical engineer. On my asking what course he would recommend to such a person, he replied that he wished he could recommend Chemistry, but on the whole he thought the chemical option of the physics course would be best, and so I adopted it.

The most distinguished graduate of Course VIII. who has made a profession of astronomy is Dr. G. E. Hale, Director of the Mount Wilson Solar Observatory. He has told me that from the moment he first saw a spectroscope, spectroscopy was the only thing for him as a profession, and that he had it always in view from that time on. So it has been with great astronomers, their bent was fixed from childhood. Still, I believe there is a chance for some people of another sort. I remember that as a boy I intended to be a carpenter; when I entered Tech, a mechanical engineer; in my second year, a chemical engineer; when I graduated, a teacher; and it was only because I failed to obtain that summer a teaching position that suited me that I took an additional year at Tech, and then, to my surprise, was offered a position as assistant in the Astro-physical Observatory of the Smithsonian Institution. My first view of the Director, Dr. S. P. Langley, and his first view of me, was when I emerged in overalls and jumper from research work in the basement of Walker Building, at Prof. Cross' request, to meet Mr. Langley, with whom I was to grow into solar astronomy for many years.

It seems to me, then, that while some astronomers are born and not made so by circumstances, there is also an opportunity for those who have the inclination for thorough, accurate research work of whatever kind.

It should not be supposed that celestial mechanics began with Newton's "Principia" and ended with La Place's "Mechanique Celeste." Our own countrymen, Newcomb, Hill, and Brown, have found no lack of opportunity in the present day.

Course VIII. has doubtless changed almost beyond recognition since my day,

(Continued on page 67.)

ASTRONOMY

(Continued from page 66.)

but however much it has been improved, I cannot think those who were there in Prof. Holman's time would be willing to exchange their recollection of him for all the improvements.

If I should state a lack of training in my time, it was in not urging upper class students to consult physical periodical literature. Doubtless this has been remedied.

I have attended many meetings in which Tech men were praised, and the general note of praise is this: The Tech man is resourceful in an emergency. He has had a training broad enough to teach him to apply what he knows to other fields than those in which he learned it. If a man learns this he can make an astronomer or anything else of himself.

PHYSICS AND ENGINEERING

By LOUIS DERR.

(Continued from page 65.)

which have come under the writer's own observation.

Every student knows what limits the lift of a suction pump; but in a certain case a much more ambitious project involving a siphon got well beyond the preliminary stages before it was pointed out that the bend of the siphon was 35 feet above the reservoir. In another case, a bicycle track was to be built for indoor races, and the corners were banked according to the ideas of the carpenter in charge. A student of the Institute figured the banking necessary, obtained a result requiring a much steeper slope of the track at the corners, and, after a conference with the writer, reported his findings to the man in charge—and was laughed at. When the track was finished, the first trial piled rider and machine in a heap at the first corner, and the track had to be rebuilt, this time according to the ideas previously ridiculed. It was successful.

Even today perpetual motion devices appear. Most of them are simply frauds upon the unwary investor, but the writer was called in all seriousness a few years ago to examine a sort of geared flywheel which revolved easily in one direction and only with difficulty in the other, and the inventor hoped he had found a new force. The explanation of the action was that of the grip of a pipe-wrench, the parts wedging themselves together or loosening according to the directions of rotation, thus causing unequal friction.

The liquid air fallacy of a few years ago affords another illustration of the saving value of a knowledge of the principles of energy. Beginning with the experimental fact that liquid air in vaporizing to atmospheric temperature expands about 800-fold, it follows that a pressure of about 12,000 lbs. per square inch can be developed. This attractive figure was promptly seized upon, and thousands of shares were sold by promotors of stock companies advertising to propel engines, ships, locomotives, and power devices of all kinds by the new agent. A fairly simple calculation, however, will show that a gallon of liquid air represents only about three-fourths of a horsepower-hour, far less than it required to produce it, and only a small fraction of the energy of an equal weight of coal.

Electrical energy is another mystery to the untrained, and is still occasionally credited with an ability to produce something for nothing. A certain dynamo was to be driven by power purchased from an adjoining factory. It was demonstrated to the engine owner that the armature could be easily spun round by hand, and a small sum was agreed upon in payment for such a trivial amount of power; all, of course, before the lights were installed. Later, the fireman felt quite sure that more coal was needed when the dynamo was running; but the deception was not discovered until long afterwards.

These stories would be ridiculous if they were not true; the only purpose in inserting them is to show that the work of every day is seldom spectacular, but rather usually concerned with very simple problems, requiring above all else a thorough familiarity with fundamental principles.

SECONDARY SCHOOLS

By W. J. DRISKO.

In these days of conservation discussion it seems almost appalling to think that in all the industrial arts where coal is burned, only 8 or 10 per cent. of the total energy is utilized; but this waste is small compared with that due to the general inefficiency of human power applied in the industrial world. It is estimated that the industrial loss to the South due to the hookworm curse is over two billion dollars yearly; yet this is as nothing compared to the waste of human energy due to incomplete development. The lack of physical energy, and of interest, stupidity, dishonesty, intemperance, and vice in general, failure to appreciate the real joys of living and doing, all these, and scores of other human weaknesses, mainly due to lack of training, are eternally clogging the gears of the industrial mill. Since only 1 or 2 per cent. of all our school children ever reach college, it is clear that any reform brought about by school training must come from the grades, the high schools and the industrial schools; and as the measure of real success is the extent of the development of ones faculties and his bearing as a citizen and member of society, the real function of a public school is first to develop human power by giving the individual the most complete command of himself, and second, to give him proper co-ordination with his kind.

Judged by the standing of the very small percentage of our public school children who reach college, the system seems a success; but from the point of view of the fitness for life of the very large percentage, there is chance for great improvement, and the reform must come through better teaching.

In the public school this means adapting all the means and methods at hand to the varying needs of each of the unsifted, always keeping in the foreground the idea that the final product, though only a cog in the great industrial machine, must be the most skilled artisan, the keenest and best developed man of business, and the best rounded out citizen that it is possible for him to be.

The trained and educated teacher, then, is surely one of society's most important servants, and in no stage of the youth's development is the impress of the teacher so important and so permanent as during that portion of adolescence corresponding to the years in high school, and perhaps the earlier years in college. The coming teacher must teach from himself, and not from some school board-prescribed text-book. He must realize that every pupil is a special problem, to be solved with enthusiasm, encouragement, sympathy, and, above all, with tact, so that in every subject under consideration there will be a distinct appeal to each particular individual from his own particular viewpoint. He must also realize that all our fine school buildings, with their marble halls, elaborate systems of heating and ventilating, their statuary and paintings, the elaborate apparatus, highly developed pedagogical methods, and fine psychological discriminations, are all mere husks and symbols of real education. Our district school of the ancient type, wanting, sadly wanting in most of these pedagogical minutiae, shows pretty conclusively that the most essential thing in real education is the direct inspiring, human uplift of the real teacher.

The trend of thought among educators seems to be in the direction of greater emphasis on sciences and modern languages, with perhaps less attention to Greek and Latin. Our better high schools and academies are offering courses in mathematics, physics and chemistry, comparing very favorably with the average college course given in these subjects forty or fifty years ago, so that both the demand and the opportunity for good teachers of science in the secondary schools are very great. The salaries offered in such schools are in general better that the colleges offer, and promotion is much more rapid. For a man who has a fondness for teaching, and who has had the training given in Course VIII, a desire to be a factor in bettering our secondary school training would seem a very laudable ambition.

HISTORICAL SKETCH

(Continued from page 65.)

cally planned Course in Physics, which should train young men for teaching or research in that subject. In view of this, in 1873 the Corporation of the Institute, acting upon the recommendation of Professor Pickering, decided to establish a course leading to a degree, which became Course VIII. There was one graduate from the course in 1875 and three in 1876.

In January, 1877, Professor Pickering resigned his professorship at the Institute, after ten years of devoted and fruitful service, to accept one of the most important scientific positions in the world, the Directorship of the Harvard College Observatory, of which institution he is still the honored head. Shortly thereafter the Physical Department at the Institute was placed in charge of the writer of this article, who had become one of its staff of instruction upon his graduation in 1870.

The Institute was in a state of financial embarrasment at this time, and it was necessary to restrict the staff of the Department to the professor and two assistants, These last were chosen from the graduates from Course VIII in 1876, Messrs. J. B. Henck, Jr., and S. W. Holman. Mr. Henck resigned after a few years, entering upon professional work, but Mr. Holman remained in the service of the Institute until failing health obliged him to retire a few years prior to his death in 1900. He had been promoted to the faculty in 1882, and was made full professor in 1893.

It is to Professor Holman's remarkable experimental skill, which has rarely been equalled in this country, combined with his excellence as a teacher, that the exceptional character of the physical laboratory work, which has been done at the Institute, is chiefly due. The Laboratory of General Physics and the Electrical Laboratory are, in fact, a memorial of his ability and devotion.

Course VIII was gradually strengthened in various ways in the years succeeding 1877. The next especially noteworthy advance, however, was the establishment, in 1882, of a Course in Electrical Engineering as an alternative to the Course in Pure Physics.

Much attention had always been given at the Institute to instruction in the applications of electricity. In 1870, Professor Pickering purchased in London a Wheatstone's bridge, slide wire bridge, Thomson Galvanometer, standard condenser and other electric measuring instruments, and these were shortly afterwards put into use by the students in the physical laboratory; this, as far as known, being the first instruction of the character to be given by any college in the United States. A course of lectures on electrical measurements was also introduced by Professor Pickering about the same time. In the spring of 1874 an important series of tests of Mr. Moses G. Farmer's newly-invented dynamo machine were made by him and Mr.. D. P. Strange.

It was soon after this date that the remarkable succession of electrical inventions which characterize the latter part of the 19th century began, with the invention in 1876 of the speaking telephone by Professor Bell, to be followed by the various developments in electric lighting and power, which have so completely transformed the conditions of living. There was no place in this country where one could study these subjects, and only one or two abroad. It was the desire of the writer to have facilities for such studies furnished by the Institute; but at first this seemed difficult for financial reasons. A course of optional lectures on applied electricity, given in 1881, was so well receivved, however, that in 1882 the Corporation decided to institute a Course in Electrical Engineering, which was announced in August of that year, and opened to students in the following month, it being the first course of the kind to be established in this country. The well-known course at Cornell University was not opened to students until a year later. The history of the Course in Electrical Engineering, which continued for twenty years to be carried on under the direction of the Department of Physics, has been given in a preceding paper in this series, and need not be referred to further.

In 1884 there was opened as a part of the Rogers Laboratory a Laboratory of Heat Measurements, which was altogether unique. This, for a long number of years, was in charge of Professor Holman, and was subsequently placed under the care of Professor Norton, whose article in the present number of The Tech gives further information regarding it.

In 1897 the Optical Laboratory was opened, in charge of Dr. Wendell.

The lecture and laboratory courses on the principles and processes of photography, including micro-photography and color photography, were introduced by Professor Derr in 1897. Elementary instruction in ordinary development and printing had been given at a very early date in the history of the laboratory, but the subsequent popularity of "snap-shot" photography rendered the continuance of this unnecessary.

In 1894 the Laboratory for Physico-Chemical and Electrochemical Measurements, suggested and planned by Professor Goodwin, was opened, and in 1901 a Course in Electrochemistry (now Course XIV), under his charge, was established. The Institute again was the pioneer in thus laying out a system of instruction in this new branch of applied physics.

During the last ten years the Course in Physics, in all its branches, has continually been strengthened, and each year it has been more complete than the year before. It has the honor to number among its graduates men who have achieved high distinction in both pure and applied science. Three of these are astronomers of world-wide reputation, several are well known as inventors, many are teachers in colleges; others are engaged in research in the scientific bureaus of the government; all have done credit to themselves and to their alma-mater.

ELECTROCHEMISTRY

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chemical laboratories of the universities and polytechnic schools of Germany and Switzerland, in order to incorporate the most modern ideas regarding equipment in the laboratory of electrochemistry. This laboratory was the outgrowth of the instruction instituted in 1894 in physico-chemical measurements, which had always included a considerable number of experiments of an electrochemical character. Since the establishment of the electrochemical laboratory proper, the laboratory course in chemical physics has been made an option in Course VIII, and the work has been confined to exact measurements in that subject, exclusive of electrochemistry. As the result of a study of the laboratory problem abroad, it was decided to equip two distinct laboratories, one provided with facilities for refined electrochemical measurements, and the other with facilities for carrying on technical processes involving the use of alternating and direct currents on a fairly large scale; in other words, a laboratory of applied electrochemistry. For the equipment of these laboratories the Executive Committee made a generous special appropriation in 1903. New apparatus has been added each year since then, and it is believed the facilities now afforded for instruction in electrochemistry are unsurpassed. Professor Thompson remained abroad from 1901 until 1903, working with Professor Lorenz at the electrochemical laboratory in Zurich, returning in the latter year to take charge of the instruction in applied electrochemistry.

The only notable change to record since the inauguration of the electrochemical option in Course VIII is the establishment of its curriculum on the basis of an independent course—Course XIV. This action was taken in the spring of 1909, the laboratories remaining as before, a portion of the Rogers Laboratory of Physics.

Upon the announcement of the course in 1901 one graduate student applied for admission in the junior year and graduated in 1903, while eight students registered in the second year, thus completing the whole curriculum in 1904. Since that time twenty-five students have been awarded the degree. The positions which they now occupy, as shown by the latest alumni register, indicate the breadth of training given by the course. About one third are filling strictly electrochemical positions, another third are following the electrical, metallurgical or general engineering profession, while the remainder are engaged in teaching, scientific research in the United States Government employ, and patent law.

Of the causes which have combined in the last twenty years to create the present demand for men trained as electrochemists, the first to be mentioned is the unparalleled development of physical chemistry, that science bridging the gap between physics and chemistry, of all chapters of which none has proved of more importance than that which deals with the mutual transformation of electric and chemical energy, and the manifold phenomena which result therefrom,—in other words, the Science of Theoretical Electrochemistry itself. In this development German investigators have been not only the pioneers, but they have also led the world in the number and importance of their contributions.

During the latter eighties and nineties students from over the civilized world were attracted to Germany to study under the leaders of the new science, becoming in their turn teachers in their own respective lands. Professorships and laboratories devoted exclusively to physical chemistry, and later to electrochemistry, were established, first at the universities, and later at the polytechnic schools, such as those at Aachen, Damstadt, Karlsruhe, and in Switzerland at Zurich. In thus early recognizing that electrochemistry was not only of growing importance as a pure science, but also that its applications to technical problems were destined to become of great and increasing value in the industrial world, German technical schools anticipated us in America. Since 1903, however, special instruction and laboratories devoted to this subject have rapidly multiplied in this country.

Prior to about 1885 the industrial applications of electrochemistry may be said to have been limited to the arts of electro-plating, electro-typing, the manufacture of certain primary and secondary batteries and to certain processes of electrolytic refining of metals, notably copper. Since then, as the result of the development of enormous quantities of electric energy at a less and less cost, and of the better understanding of the laws and phenomena underlying the transformation of electrical and chemical energy, new electrochemical processes have rapidly come into being. Among these are usually, although illogically, included those chemical processes taking place at exceedingly high temperatures, such as are readily produced only in the electric furnace,—processes in which heat energy rather than electric energy as such, plays the essential role. A number of industries, some of which have already reached large magnitudes, and which will be more fully discussed under the heading, Applied Electrochemistry, have been the immediate result of this activity. At the present time electrometallurgical methods are also assuming more and more importance, and it now appears as if electric furnace methods for the production of iron and steel have come to stay, at least as auxilcesses.

In the industrial development of the science the United States has taken the lead, thanks in part to the enormous power available at Niagara for the production of electrical energy, and in part to the characteristic American readiness to try out a novel process on a large scale, often at considerable financial risk, before it has been "demonstrated."

As indicative of the growing interest in electrochemistry in this country, it may be said that prior to 1902 there was no journal especially devoted to this science and no society primarily concerned with its interests. In that year the American Electrochemical Society was established, and its membership has increased until at the present time it is over one thousand. Two volumes of transactions are published annually, and a monthly journal serves to circulate the current technical news, patent literature, etc. The corresponding society, now known as the Bunsen Gesellschaft, established in 1894 in Germany, is also a very active and thriving society. England, too, has followed the example of Germany and America in the establishment not only of special laboratories for instruction in Electrochemistry, as that for example at the University of Manchester, but also an electrochemical society—the Faraday Society—devoted wholly to electrochemical interests.

To be properly equipped to attack electrochemical problems, particularly if they involve processes to be carried out on an industrial scale, it is essential that one should have a thorough grounding in the theory of direct and alternating currents and their application to the machinery on the one hand, and a corresponding thorough knowledge of chemistry, including theoretical, analytical and applied chemistry on the other. It is this combination of studies which is offered in Course XIV, and which forms the backbone of the course and basis for the professional work in electrochemistry itself. In addition to the fundamental studies, as many engineering subjects, such as mechanism and steam engineering, are included as the time in a four years' course permits. The range of subjects with which it is desirable an electrochemist should be familiar is so wide, however, that it is practically impossible to include all which are admittedly valuable in a four years' course. For this reason, a student who can arrange his work on a five years' basis will find it possible to include a number of additional subjects to great advantage. This may also be accomplished by following the four years' course by a fifth year, leading to the Master's degree.

From the nature of the subjects of electricity and chemistry, which form so large a part of the curriculum of Course XIV, much of the instruction is given in the laboratory. The problems to which an electrochemist is likely to be called upon to solve in the practice of his profession are usually experimental in character; Hence a student intending to take this course should have a distinct fondness for experimental work, and the greater his originality and power of attacking new problems the greater are his chances for eminent success. Skill in manipulation and fondness for experimentation, however, are not alone sufficient to insure success in this course. Good mathematical ability is equally essential to cope with the problems arising in theoretical and applied electricity, particularly that branch treating of alternating currents, the application of which is of great importance in many electrical furnace operations.

With the present outlook, a man who has successfully completed Course XIV should have no difficulty in obtaining a position for which his training has fitted him. It should never be lost sight of, however, that a successful career depends not only upon the knowledge, and of much greater importance, the power to apply it, but also on character, savoir faire, and the ability to meet and deal with men. The development of these essentials for success in life should never for a moment be lost sight of during student days. In many instances, it is these more than scholarship alone which recommend a student on graduation for positions of responsibility and larger opportunity.

EXPERIMENTAL PHYSICS

By H. M. GOODWIN

The Course in Physics is often characterized as the "hardest Course at Tech." Those who are fortunate enough to count themselves among its graduates will not, of course, dispute the title, but it may be doubted whether a properly prepared student finds the work more difficult than that required in certain of the Engineering Courses, inasmuch as the Course is homogeneous in character and contains fewer subjects than are required in the more composite Courses. Be this as it may, the Course does require for its satisfactory completion unquestionable ability on the part of the student in two distinct directions: he must be a good mathematician, and he must have reasonable skill in laboratory manipulation, and in the interpretation of experimental results. The two options offered in the Course (the mathematical and chemical options, respectively,) afford considerable latitude in the direction of specialization; but whichever option he may elect, the student must have a clear logical mind and a love

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EXPERIMENTAL PHYSICS

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for science for its own sake. These may be regarded as two essential qualifications for one proposing to elect this Course.

The mathematical and theoretical aspects of the Course are described elsewhere. I desire to point out here the salient features of the laboratory side of the instruction. Course VIII offers to a greater extent than any other Course at the Institute the opportunity to become familiar as an undergraduate with the fundamental and exact methods of scientific research. This has been recognized from the beginning as an essential feature of a Course, which aims to provide a thorough foundation for further graduate study, as preparation for the career of an investigator or teacher in a higher institution of learning. To provide this training the curriculum is so planned that, parallel with the development of theoretical physics which extends continuously throughout the third and fourth year, the student is given the opportunity to carry on a large amount of correlated laboratory work culminating in his thesis. As preparation for this work he takes the Course in General Physical Measurements in the sophomore and the first part of the junior year, which is common to all Courses in science and engineering. This Course, accompanied by that of Precision of Measurements, is planned primarily to train the student at the very outset of his work in the proper method of approaching a piece of experimental investigation, whether it be purely scientific or technical, special emphasis being laid upon economy of time and labor both in performing the work and computing results. Experience gained from this training is fundamental and applicable to all experimental work quite independent of its exact nature. It is of far greater permanent value than familiarity with any particular process or method or even skill in manipulation, important as this unquestionably is. It may be of interest to note that the subject of Precision of Measurements in a more extended and specialized form was originally developed by Professor Holman for the fourth-year students in Courses VI and VIII. In recent years, however, the elements of the subject have been incorporated into nearly all the Institute Courses at the very outset of the laboratory work, to the great advantage to the latter.

For the student in Physics, the Laboratory Course in General Physics and in Heat, is followed by more advanced work in the special laboratories devoted to electrical, heat, and optical measurements, with the option of electing, if he so desires, additional advanced work, including exact physico-chemical measurements. In the advanced work the student is thrown more and more upon his own resources, specific directions giving place to references to standard treatises in English, French, and German. The experiments assume more the nature of short researches, which are to be approached, discussed and reported upon in the manner of short theses. This is particularly the case with the work in advanced physical measurements, optical laboratory, and the laboratory of chemical physics. The Rogers Laboratory may well be proud of its equipment of apparatus which is available for this instruction. Additions are certainly being made and the equipment kept abreast of the times. Although the location of the Institute precludes the possibility of certain kinds of research requiring great steadiness, the expedients which have to be adopted to overcome the effects of mechanical and magnetic disturbances, form a valuable training for the student.

During the first term of the fourth year each student, with the advice of his instructors, chooses his thesis, a particularly important matter in Course VIII, as much time in the fourth year is alloted to this work. Whenever the student has sufficient judgment to choose a suitable subject for investigation, he is encouraged to make his own selection. In this, however, his ambition frequently overleaps the mark, and problems, such, for example as the determination of the mean density of the earth, which the most skilled physicist might well hesitate to undertake, are not infrequently suggested. On the other hand, there are many interesting short researches which may be undertaken with a reasonable degree of hope of completion in the time available for thesis work. The result has been the publication of a number of undergraduate theses, which have been real contributions to science. It is not too much to say that some of these have been of a quality equal to those accepted at some institutions for higher degrees. As a preliminary step toward beginning work on his research, each student is expected to make an exhaustive study of the literature pertaining to his proposed work, this constituting a part of his work in the colloquium. He realizes here, if he has not already done so, the importance of a good reading knowledge of French and German, an indispensable accomplishment for a man of science. Students would do well to appreciate this early in their course, and make a practice of keeping up their modern languages by reading foreign literature or current scientific periodicals throughout the second and third years.

By the manner in which a student attacks and works out his thesis, much may usually be inferred of his power of independent thinking, and his probable success as a subsequent investigator. The thesis is for this reason one of the most important, if not the most important subject which the physicist undertakes in his entire course. In carrying on his investigation he comes into intimate relations with the instructor with whom he is working, and it is here that the advantage of the small number of students electing Course VIII is most evident, since far more individual attention on the part of the instructor is possible than with the great numbers of students taking the Engineering Courses.

A fifth year of graduate work, leading to the Master's degree, has been arranged to meet the needs of students who desire to continue their research work and to take additional studies, and this is highly recommended to those who feel that they can afford the time. For those who intend to become investigators, or teachers in universities or technical schools, it is almost essential at the present time that sooner or later they make their Doctor's degree. To obtain breadth of view and to increase his acquaintance with other men in the profession, the writer believes it is desirable that a student of Physics take his Doctor's degree at a different institution from that at which he has pursued his undergraduate work. For this reason the department recommends, and in a number of instances the Institute has sent, as Fellows, graduates of Course VIII, to make their Doctor's degree either abroad or with some eminent physicist at another American university. The question of the relative merits of these two courses is a broad one, on which much might be said, and on which there is probably a difference of opinion. All things considered, it is the opinion of the writer that for most American students two or three years of graduate study abroad, with the advantages which a residence in Europe offers, affords a more valuable preparation for a successful career in science than the same period of study spent at an American university.

In closing these remarks on some of the leading features of Course VIII, it may not be inappropriate to say, that at no time has the demand for scientifically trained men been so great as at present. The various Government bureaus, the Carnegie Institution, the research laboratories being established in connection with great industrial concerns and the rapidly growing western universities, all need men with the kind of education given in the Course in Physics. The demand for our men in the last few years has been far in excess of the supply. It is, of course, not necessary to reiterate that the pecuniary rewards of the teacher or scientist are never likely to be large. He must look for his chief compensations in the pleasure of his vocation, the companionship of associates of congenial tastes, the leisure for study, investigation and travel afforded by long vacations and the recognized place in the community and in society which the broad man of science is certain to attain.

APPLIED ELECTROCHEMISTRY

By M. DeKAY THOMPSON.

The instruction in Applied Electrochemistry has the object of making students familiar with the methods employed in the most important electrochemical industries. In order to show to what extent this is accomplished, a short survey of the field will be necessary.

Electrochemical industries may be classed under two general divisions, which are respectively the production or refining of metals and chemical compounds by means of electricity, and production of electricity from chemical change. The second division includes the subject of storage batteries and primary cells. As regards money invested and power required, the latter is relatively insignificant compared with the former.

On account of the large amount of power required for the first class of electrochemical industries, they are generally located where power is cheapest, as at large water falls. A large number of such industries are represented at Niagara Falls, where at present 300,000-horse power is developed. The principal products are carborundum, fused alumnia (called "alundum"), artificial graphite, alkali and chlorine, aluminum and calcium carbide. To indicate the magnitude of these industries the production in 1908 is given in the following table:

	Pounds.	Value.
Carborundum	4,907,000	$294,430
Alundum	3,160,000	189,600
Graphite	7,385,511	502,667
Aluminum 13,000,000		4,095,000
Calcium Carbide...84,000,000		1,800,000

The increase in production per year is very large in all of these materials, and the number of such industries is steadily increasing. For instance, the carborundum company has recently begun to produce silicon on a commercial scale. In 1908 five hundred tons of 90 per cent. silicon were sold for the purpose of refining steel. Also, at the present time, a large plant is building for the production of calcium cyanamide. This is the starting point in the fixation of atmospheric nitrogen, and is made by the direct union of nitrogen and calcium carbide at about 1,000 deg. C. It seems that the electric furnace products are at present increasing with greater rapidity, both in quantity and number, than those made in aqueous solution.

An older, but a very important, electrochemical industry is the refining of copper. There are eight refineries in America, with a total output of 360,000 tons a year. The most recent metal to be refined commercially is lead. The refining of steel is also carried out now in electric furnaces, both of the Heroult and induction type.

One of the latest and important industries is the fixation of atmospheric nitrogen by direct combination with oxygen in an electric arc furnace. This was attempted unsuccessfully at Niagara Falls, but is now carried out by several European companies. The first plant was at Notodden, Norway; there is another at Vevey, Switzerland, and the "Badische Anilin und Soda Fabrik" has also taken it up in Germany.

There are also a large number of electrochemical industries which are carried out on a somewhat smaller scale than the ones above enumerated. In many instances factories manufacture some electrochemical product for their own use alone. Examples of these kinds are electroplating and the electrolytic production of copper tubes, wire, powder and parabolic mirrors; electrotyping; the production of bleaching solutions by paper factories for their own use by the electrolysis of chloride solutions; the production of hydrogen and oxygen by the electrolysis of water; electrolytic oxidation and reduction, such as the oxidation of potassium ferrocyanide to potassium ferricyanide, of chromium salts to chromates, iodoform from iodide, chlorates and perchlorates from chlorides. Examples of electrolytic reduction are the production of lead from lead sulphide, carried out at Niagara Falls for some time, but finally given up on account of the bad effect of hydrogen sulphide on the workmen, and the production of the lower salts of chromium, venadium, molybdenum and titanium. The production of ozone by the silent discharge of electricity is carried out where it is to be used. Finally, the large extent to which electricity is used in making quantitative chemical analyses should be mentioned.

This brief sketch will give an idea of the kind of work that is carried out by electrochemical means.

The instruction in electrochemistry begins in the first term of the fourth year, and continues through the whole year. Theoretical electrochemistry is taught in a course of thirty lectures in the first term, accompanied by a laboratory course of 105 hours. The laboratory work consists principally in potential and conductivity measurements.

In the second term, applied electrochemistry is given in a course of twenty lectures, taking up all of the principal electrochemical industries in detail, with the exception of electrometallurgy, which is treated in the special course. When possible, each process is discussed from a general or theoretical standpoint before describing the actual methods used in carrying it out.

The laboratory course of 45 hours accompanying this lecture course consists in experiments modelled on the chief industries. Special attention is paid to the measurement of the current, voltage power, as well as the temperature involved in each process. Most important among these are the electric furnace experiments, which consist in the production of carborundum, silicon, aluminum, calcium carbide and iron. Then follow electrolyses in aqueous solutions, consisting in a storage battery test and the production of bleaching solution, chlorate, white lead and other compounds.

A 10 kilowatt induction furnace has been added to the equipment this year, which will also be used in the regular laboratory work, as well as for research work.

THEORETICAL PHYSICS

By DANIEL F. COMSTOCK.

It is not my intention in this short article to make an outline of Course VIII, this has been ably done in other articles in this number. What I wish to do is to talk quite freely about the kind of thing that the different studies in this course are designed to teach.

There seems to be properly current a very curious idea respecting the meaning of the word "theoretical." A good many students seem to think that the so-called "theoretical" side of any subject is only a mental game which touches more or less intimately at certain points the really practical subject itself. The idea causes a good many to turn away, when they get a chance, from courses which bear the adjective "theoretical," and turn toward the so-called practical. It is needless to say that this idea represents what is far from the truth. The theoretical side of a subject, properly understood, is merely the side of it which requires the most thought. This side, therefore, is the one least obvious, least sensational, and one the advantages of which are not easily appreciated from the outside.

Speaking in a very general way, the value of the theoretical courses at the Institute may be described under three heads

First: Increase of Mental Power.

Second: Training for Original Research.

Third: Training for the Profession of Teaching in Higher Institutions of Learning.

Of these three the first two are not generally appreciated.

With regard to the "teaching to think," we have to consider the well-known distinction between knowledge and mental power. Knowledge is almost always over estimated by the student and mental power very greatly under estimated. For this reason a great many students cannot understnd why certain types of problems are given them for solution, problems which seem to be very far from being of a practical kind; the conditions stated in the problem, they see, could never actually be carried out in practice, and they therefore conclude that the problem is of very little value. The problem does not add much to their knowledge, but anyone who has had any experience at all with the world of effort and achievement knows that it is far more important to have a well-trained mind than to be stuffed up, so to speak, with knowledge. Of course knowledge is also necessary, but it would seem to some almost incredible if they were told how rapidly a well-trained mind can assimilate knowledge. One case in particular, which I am fond of relating, is that of a Tech. man who went West and took charge of the electric meter department in a small Western city. He had been a close student of electricity and he had a well-trained mind, but two weeks before he left for the West he had never seen the inside of an electrical meter. He went to the meter department of an Eastern city and spent a day looking over the whole repair department, where we can easily guess that he understood everything that he saw.

He told me, also, that for a week he put in most of his time studying modern meter practice, and a few days later he went West. He found, rather to his surprise, that he knew more about meters than anyone in the city, and he found himself an acknowledged meter expert. He did his work well. He transformed a very dilapidated meter system into a thoroughly efficient one, was highly praised for his work, and, when he left for another position, he considered his work there entirely satisfactory.

This, of course, is no exceptional case, it is only an example. Suppose that man had not appreciated the value of general scientific training, and had started in at the beginning by studying meters. It is very doubtful if he would have been nearly as efficient as he actually was, and, moreover, there would have been nothing else that he could handle. As it was, he was equally fitted at two weeks' notice to take up any one of countless different positions involving only a little easily attained special knowledge on top of his general training.

A man who does not understand what this example implies as to the working of the human mind and the nature of success in engineering careers has missed one of the profoundest truths which he could learn.

What I have said above with regard to the enormous value of mental power as distinguished from knowledge, applies to all scientific professions alike. Next, I wish to speak of the advantages of so-called theoretical training to the pure scientist. The life and ideals of the scientist seems to be almost absurdly misunderstood by people in general, and particularly by young students. The activities of the inventor are appreciated by all, but the function of the pure scientist seems to be much harder for the average person to understand.

The activities and ideals of the pure scientist are very closely similar to those of the explorer, with this important exception, that whereas the explorer knows that the earth is limited, and that, therefore, his field of exploration is limited, the pure scientist knows nothing of the kind, for our present knowledge , though great, is so extremely small compared with what can be known, that the domain in which new truth can be discovered is practicaly infinite. There is an amusing popular idea that there is very little new being discovered; that is, I mean, absolutely new knowledge. It would come as a surprise, I suppose, to those who hold this view, to know that "Science Abstracts," a periodical which abstracts all of the important original papers published in the domain of physics, dealt with 2,161 papers during the year 1909. Every one of these papers strictly speaking, represented a new discovery. Not all of them, of course, were of great importance, but it is very rash indeed to assume what new truths will be epoch making and what will be forever valueless, At the time of Faraday's electrical discoveries in the early 40's, the "Youth's Companion" stated, I am told, that although these experiments were extremely interesting as curiosities, the effects were so small that they could never be put to any practical use. As a matter of fact, our knowledge of all induction phenomena, without which we may almost say there would be no electric engineering, rests entirely on the cornerstone of these very experiments of Faraday.

Never was there a time when the field for discovery was greater than at the present day; but there are men of remarkable ability already in it, and the untrained explorer has very little chance to win new knowledge. His insight into the habits of nature,—for, after all, that is what we mean by "natural law,"—must be broad and profound, and the so-called theoretical side of his studies is, from one point of view, the most important part of the study which gives him this insight.

There is, perhaps, a little less need of touching on the teaching side of the subject, partly because this is the side usually emphasized, and partly because, although greatly misunderstood in some ways, the ideals of the teacher are better appreciated.

There is a great demand at present for able teachers, a demand which is greater than the supply, and although it is true at the present time that salaries for teachers are low, it is also true, and this point is often missed, that the teacher in a higher institution of learning has already many of the things that a man in another profession will use money to buy. Moreover, a man with any ability can nearly always supplement his salary by means of outside activity, for which, in general, he has sufficient time.

It is impossible to give much new insight into the theoretical physics courses at the Institute by simply naming them, or by quoting from the Catalogue. It is the peculiar property of courses which involve more or less profound thinking, that they cannot be described easily to one who has not taken them. This is a corrollary to a general axiom, which might be put in the paradoxical form that "Only the obvious is obvious."

The Course in Theoretical Physics commences where the general second year course leaves off, and takes up the divisions of physics in the following order

Dynamics.
Electricity.
Optics.
General Theory of Heat and Heat Phenomena.

It is proper to begin with dynamics, because dynamics is the science of motter, motion, and force, and it therefore touches most closely our common everyday experience. The general mathematical methods which are applicable in all fields of physics can therefore be best introduced in the subject where the phenomena themselves are in part already familiar to the student. In these courses a great deal of original work on the part of the student is required. It does not do a man much good to sit in a chair and watch somebody else swing Indian clubs, and in a somewhat similar way, it is not very beneficial mentally to simply hear about things; the important thing is to learn to do, learn to think productively, and this is accomplished by requiring the student to work out a large number of problems.

After the course in dynamics is finished, electricity, optics, etc., follow in a natural order; for as soon as we get below the surface in the study of physical phenomena, it becomes obvious that many of the distinctions which are necessary in elementary exposition are really of little importance in the profounder study of the subject. The various habits of nature are very similar.

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The increasing demand for trained physicists should operate to the advantage of graduates of Course VIII. The large physical laboratories recently constructed or now being built for colleges, universities and technical schools afford improved facilities for research, and requires that important additions be made to the staffs of instructors. The Bureau of Standards, with its several buildings and remarkable instrumental equipement, has drawn many physicists from the schools, and will doubtless require more good men. Graduates of Course VIII are needed in astrophysical observatories, where an acquaintance with physical methods is the best agent in the advancement of reseach. The laboratories which are being established by manufacturing corporations also employ physicists, and furnish ecellent opportunities for investigation. Under existing conditions, therefore, it should not be difficult for a good man to obtain a satisfactory start after graduation from the Institute.

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It is a pleasure to think of the opportunities that lie before the student of physics at the Institute. Twenty years ago Course VIII was highly developed, and offered unusual advantages. But since that time the addition of many new subjects, the constant revision and improvement of the instruction to keep pace with the remarkable progress of science, the purchase of a rich collection of instruments and apparatus, the increased facilities for work in related fields: these and other changes have placed the Department of Physics on the highest plane, and produced a course admirably adapted for the education of teachers and investigators. As an investigator in science I have been especially struck with the spirit of recearch which permeates the laboratory. In spite of their heavy duties of instruction, the members of the Department is some way secure time for research, so that the visitor finds himself in the presence of the living and growing science—not in a museum where the works of the past are gathered together for exhibition. Every facility is at hand: the excellent and varied courses of instruction, logically arranged in the sequence which long experience has shown to be best adapted to the students' needs; the extensive laboratories, supplied with an immense equipement of the best apparatus; a great physical library; and the aid and encouragement of a large corps of the ablest instructors.

But the prospective student of physics should not forget that the pursuit of pure science rarely or never brings large financial reward. The salaries of teachers and investigators are much lower, on the average, than those received by engineers. I doubt, however, whether the engineer is more richly repaid than the scientific investigator. The pleasure of exploring an unknown country, and climbing from time to time some elevation which commands a new and unexpected view, is hardly to be equalled. If a student combine energy and tenacity of purpose with ability and enthusiastic devotion to science, he may well be content to exchange the possibility of a large salary for the unique satisfaction afforded by a life or research.

G. E. HALE.

The Course VIII. of today and of fifteen years ago are two very different things, but they both give the student a good preparation for the study of pure mathematics in that, besides the drill courses in the elements (through the calculus) they provide a considerable amount of instruction in the applications and also a satisfactory amount of advanced and pure mathematics. The systematization of the instruction in theoretical physics appears to me an exceedingly important advance in rendering the course more efficient, not only for the physicist, but also for the pure mathematician.

It should be remembered that a large percentage of those who make pure mathematics their career, become necessarily teachers in schools of engineering. For this reason it has always seemed to me that besides the theoretical mechanics now given in Course VIII., there should also be included some of the applied mechanics of Course II., in order that the student may know at first hand the problems of the engineer and the methods used in their solution. me unfortunate that descriptive geom-

It has, moreover, always seemed to etry has not been required of Course VIII. More than any other subject it develops the power to visualize space relations. and for that reason is not less essential to the mathematician than, for its practical applications, it is to the engineer.

As to the advanced courses offered in mathematics, it is sufficient to say that their value for the student of pure mathematics is limited only by the amount of intensive work he can put on them. Such a student should remember, however, that the theory of functions of a real variable and of a complex variable underlie all his future work, and that after reaching a sufficient maturity he cannot give too much attention to them.

CHARLES N. HASKINS,
Dartmouth College.

It gives me pleasure to testify as to the preparation that Course VIII. gives for the work of a college teacher and graduate student.

In the first place, fortunately the amount of time given to Physics and the closely allied subjects is sufficient to give a reasonably thorough grounding in the principles of the science and some of their technical applications and the essentials of accurate, intelligent scientific observation. In the drill in precision of measurements and the use of all sorts of instruments and of various methods for measuring the same quantity, a critical judgment is acquired that is invaluable to the research student and teacher.

Course VIII., very wisely I think, places especial importance upon the subjugation of the technical applications to their theoretical foundation.

Unfortunately many technical schools and some universities, alas, do not realize the importance of the pure science. This answers for the training of the mediocre engineers, but it does not give the broad foundation in mathematics and science that an original, great engineer requires. I wish the most capable students at the Institute of Technology would combine Course VIII. with the more specialized engineering courses. The result could not fail to be a happy one.

As a preparation for research work the training offered by Course VIII. is admirable. The technique of accurate experimentation is acquired, and a sound foundation for more advanced work in any direction.

If one observes the trend of research in the biological and psychological sciences, as well as in astronomy, chemistry and geology, he will note how much the instruments and methods of Physics have been introduced into the methods for advancing knowledge in all these sciences. The more I observe the advances in education and science, the more I am convinced that Course VIII. offers an ideal preparation in many lines of work.

MARGARET E. MALTBY.

In response to a request for a letter dealing with the preparation which Course VIII. gives for patent work, I would state that the general subject of patent work is such a broad one that it has to be considered from several points of view.

In the first place we may divide patent work into three classes:—that which relates to the examination of applications for patents by the employees of the United States Patent Office; that which relates to the preparation and prosecution of applications by patent attorneys or solicitors; that which relates to the prosecution or defence of patent suits in the courts. The above will indicate in a general way the comprehensiveness of the subject; but each one of the subdivisions will embrace numerous classes of work.

In order to be appointed an assistant examiner in the Patent Office it is necessary that the applicant pass a rigid examination based upon the following general subjects: physics, chemistry, mathematics, technics, mechanical drawings, French or German.

The subject of technics covers the general field of mechanics, mechanic arts, industrial arts and processes, and applied chemistry. Under the subject of "mechanical drawing," the applicant is given copies of drawings of machinery similar to those which appear as a part of the specification of a patent and is required to fully describe the construction and operation of the machine. Only the name or use of the machine is disclosed.

In view of the above requirements it will be apparent that Course VIII. will furnish adequate preparation for the examination. The subject of technics is a broad one and it may well be that the applicant will have to study some subjects not included in the curriculum of Course VIII. A good text-book will however furnish sufficient information on any of the subjects.

As to the value of Course VIII. for work in the Patent Office, it depends almost entirely upon the class of work to which a man is assigned. If for instance it becomes his duty to examine applications for electrical or optical devices or those relating to chemistry, his training in Course VIII. may be espe-

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cially helpful. In numerous other cases it is hard to see that the training of this Course is any more helpful than that of other courses.

Much the same remarks apply to the work in connection with the preparation of applications for patents. It depends upon the character of the apparatus or device for which a patent is sought. If it be a wireless telegraph outfit a Course VIII. man would be especially qualified to write up an application for a patent and conduct its prosecution before the Patent Office.

As to the question of patent litigation, it is essential if a man is to appear as counsel in a patent suit that he be a member of the bar. To attain this position he must pass a bar examination, and this involves preparation. While there does not appear to be much connection between Course VIII. and a course in law, .. is evident that in law as in science a man must know how to study to best advantage, must be able to distinguish the important from the unimportant, and must be able clearly to discuss and reproduce upon examination that which he has previously studied.

I hope that the foregoing will in a measure answer the question as to the preparation which Course VIII. gives for patent work, but the subject may be considered from so many joints of view that it is impossible to give it complete treatment in a brief letter.

WALTER J. GILL, JR.

At the request of Dr. H. M. Goodwin I beg to hand you this letter, which I trust may contain something of interest and help to your readers, particularly those who contemplate following the profession just beginning to be known as Electrochemical and Electrometallurgical Engineering.

Three years of electric furnace work have given me some insight into the possibilities in this new field. Electrometallurgical engineering is a branch of engineering which, perhaps more than any other, will be useful in accomplishing greater economies in the production of certain manufactured products, especially the metals, and is destined, I think, to play a very important part in the conservation movement which is growing so rapidly today.

My connection with this branch of engineering began in Oregon in 1906, where the talk of smelting the "Black Sands" by electricity created quite a sensation. I brought some of these sands back to the Institute for the purpose of smelting them if possible, and, together with Mr. F. S. MacGregor, built an electric furnace for this purpose along the lines of the furnace built by Dr. Paul Heroult, the gentleman so well known for his electric furnace work in connection with alluminum and iron and steel. The possibility of using the water power, so plenty in the West, to reduce iron ore, attracted me greatly after leaving the Institute, and since then I have devoted practically all my time to the application of electricity in connection with the smelting and refining of iron, going where the opportunity offered to further acquaint myself with this work. I was connected with the Noble Electric Steel Company in California, where Dr. Heroult built his 2000 K. W. electric iron ore smelting furnace, and assisted in the tests made in that furnace. I later entered the employ of the Illinois Steel Company, where now a 15-ton Heroult steel furnace is being operated. At the present time I am acting as engineer for the American Electric smelting and Engineering Company, devoting my time exclusively to electric furnace engineering work.

This field is so broad that the preparation for it should include the same preparation as for electric engineering work, and also that for chemical and metallurgical work. The requirements of an electrical engineering nature are of utmost importance, especially those touched on in the course of Theoretical Electricity, such as given by Professor Clifford at the time I attended the Institute; and, on the other hand, the metallurgical and the chemical requirements are equally essential, based on the course on Theoretical Chemistry, which I was fortunate enough to take under Dr. Noyes. The field is also so new that the opportunities to be found in connection with the electrochemical laboratories of the Institute are very attractive. One appreciates these very much more after leaving, when he can no longer take advantage of them. Happily I did take advantage of them while there, and I have been very thankful for that ever since. In this connection, and as a suggestion to those looking for thesis subjects, the possibilities of controlling metallurgical reactions at elevated temperatures, independently of the source of heat and the matter of solution of gases in molten baths, offer a most fertile field for research. I trust that my letter may impress some man, undecided as to what course to take, or even as to the choice of thesis, with the opportunity before him of working in an almost untouched field. If thesis subjects were chosen by the end of the first year I think it would make many courses more valuable, because the student could see more clearly their use.

As to our engineering training proper, it seems impossible to get this until after one leaves school and actually gets out in the work. Perhaps some day, when our engineers are better able to co-operate with our educational systems, and our professors, in the development of our industries, it may then be possible to enable a man to make much more of these opportunities which he later on realizes were before him at the Institute, but it is at least possible now for us who are out to indicate what parts of our course have been most useful and to urge others to think of these things.

The application of the principles of physical chemistry and electricity to practical work is very important. I wish to cite just one example of the present waste in one of our industries, due to lack of more efficient processes, where this branch of engineering should bring about a solution, For every ton of steel produced in this country from pig iron there is about 3 per cent. of iron oxidized, which must be again reduced in a blast furnace or some other furnace. This means that in the production of the fifteen million tons of steel made annually in the United States the loss of iron from this source alone amounts to 450,000 tons. This further means that the coke used to again reduce this oxidized iron is approximately 450,000 tons. This amount of coke is a dead waste. It would seem that the theories of conservation are applicable in the steel mill as well as in the forest. The application of electrometallurgical methods is the only possible means now apparent for saving this extreme waste, and there are many other examples of waste just as large where this branch of engineering can produce most important savings.

The Institute offers, in Course XIV, a unique educational preparation for such a profession by combining the important parts of the electrical engineering course and of the chemical courses with increasingly good laboratory facilities. The courses on Theoretical Electricity and Theoretical Chemistry, as given when I attended the Institute, were theoretical in name, but these courses have been of greatest practical value to me. In combination with these, the electrochemical laboratory offers precious opportunities, and if our metallurgical courses can include such work as outlined in Professor J. W. Richards' book on "Metallurgical Calculations," it seems to me that the Institute offers advantages which can hardly be found elsewhere.

ALBERT E. GREENE, 1907.

In response to your request for a few words in regard to the preparation which has been received by a graduate of Course XIV, I give below an outline of my impressions after five years of technical and business experience.

When the young man graduates from the high or preparatory school, his experience in the world has seldom been sufficient to warrant a final judgment of a choice of occupation for life. Mentally he scans the various branches of personal endeavor, to his mind classified as teachers, scientists, lawyers, doctors, engineers, and business men. By the process of elimination he sets aside those vocations in which he feels confident he would not care to engage, and then, arranging the others in order of their interest to him, he considers at what school general opinion (often bound by convention and dominated by the expressions of academic graduates) advises him to pursue his training. In much the same manner, but in a more restricted degree, and with the advice of men whose interests are more nearly his own, this same method of selection is followed at the time of making a choice of course in the Institute.

I would divide the aims of the men who enter the Institute into three classes: to become a teacher or scientist; to become primarily and essentially an engineer, a man whose success in later life will be measured by the weight given to his opinion of engineering possibilities (in whatever branch he may have devoted his energies); or to become, with his technical education as the path thereto, essentially a business man (in the sense of managing manufacturing or engineering enterprises). There is still a prevalent feeling that the young man who looks forward to a purely business career should attend an academic school, there to study—What? The subjects or the benefit of the curriculum are seldom considered. But it now seems that the developing ramification of business, the many industries falling under one head and directed by the same group of men, the necessity of being familiar with the principles underlying these various industries without long study "in the works" of each branch, are all tending to alter this old idea, and as the graduates of technical schools consider these matters, they are bringing about a sentiment toward technical education as the best preparation for business life.

It is from this point of view that the writer, speaking from his own experience, would suggest a careful consideration of the Electrochemical Course at the Institute. Not that this is the only attraction offered by the course, for Course XIV provides a specific training, laying an excellent foundation for the engineer who has to deal with any of our great chemical plants, using electricity as an agent of their production; a unique training for the man purposing to study patent law; an excellent preparation for the future teacher, and so on; but the aspect of the preparation as a training for engineering business, it seems to me, has not been given the consideration which its merits deserve.

It seems to the writer that Course XIV, with its thorough and detailed study of one important department of applied science which has much in common with several departments of engineering, gives an efficient starting point for a man's subsequent study, if fortune leads him into a business career in connection with any industry of which he has learned the technical fundamentals.

HENRY A. WENTWORTH, 1905.